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Multilevel Governance in Sea Level Rise Adaptation: An Analysis of U.S. Cities

Emma Eisendrath
Oberlin College

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By Emma Eisendrath

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Introduction

Climate change is a scientific certainty. With increased greenhouse gas (GHG) emissions since the Industrial Revolution, the earth has grown warmer and climate patterns have shifted. Rising temperatures have caused ice sheets to shrink, oceans to warm, glaciers to retreat, extreme storms to increase, oceans to acidify, and sea levels to rise. With roughly 164 million Americans living in counties along the coast and at least 25 million people living in designated flood risk zones, the United States must plan for effective sea level rise adaptation (SLRA).[1] This paper examines the effect of different governing structures on the capacity for effective SLRA.

The paper is outlined in the following way. First, I look at the impact of climate change on sea level rise, generally. Then I examine existing federal programs that manage flooding and sea level rise policy. I focus on the benefits and drawbacks of the Federal Emergency Management Agency (FEMA)'s SLRA resources, including the National Flood Insurance Program (NFIP). Next, I outline existing theories on multilevel governance in environmental policy and develop my own categorical framework based on patterns I noticed in my research. City-run sea level rise adaptation (SLRA) policy will be the focus of this paper; my categorical framework looks at levels of city autonomy in SLRA planning. I combine this framework with an evaluative framework from the Georgetown Climate Center (GCC) that lists criteria for successful SLRA planning.

I discuss four major case studies: New York City, Hoboken, Atlantic City, and Charleston. For each case, I outline relevant city policy and state policy to determine the level of city autonomy in SLRA management. To evaluate the effectiveness of the different governing practices in each city, I compare each city's SLRA plans to a set of criteria for successful SLRA

[1] "Climate Impacts on Coastal Areas," EPA, Accessed December 4, 2016. https://www.epa.gov/climate-impacts/climate-impacts-coastal-areas#ref1;"National Climate Assessment," U.S. Global Change Research Program, last modified 2014. Accessed December 4, 2016.

preparedness created by the Georgetown Climate Center. I also provide a brief analysis of four other cities: Miami Beach, Florida; Kivalina, Alaska; Norfolk, Virginia; and Seattle, Washington.

I chose to look at city-level management because decision making at the city level is a crucial component of environmental governance. Each city has a unique set of environmental concerns. In New York State, for example, only a fraction of the state touches the ocean, so most of the state has little to no interest in sea level rise issues. Along with unique environmental situations, cities also have a unique economic role in the larger federalist structure. According to a report from the Organization for Economic and Co-operation Development (OECD) on the importance of cities in environmental governance, cities contribute about ⅓ of national growth.[2] The report states that cities hold a unique role in environmental planning because of their concentration of income and productivity; this concentration allows for innovative cooperation between a wide variety of workers and companies.[3] Cities are also responsible for significant amounts of pollution, accounting for ⅔ of the world's energy needs and CO2 emissions.[4] As both hubs of innovation and pollution, cities have both the capacity and the need for environmental policy creation.

Cities are important leaders in SLRA policy decision making because they hold most of the people and wealth that will be impacted by SLR. In each coastal state, most of the population is concentrated in cities. In New York State, for example, almost half of the population lives in coastal NYC.[5] Coastal areas have population densities at least six times larger than inland

[2]Stephen Hammer, *et al*, "Cities and Green Growth: A Conceptual Framework," *OECD Regional Development Working Papers*, 2011, doi: http://dx.doi.org/10.1787/5kg0tflmzx34-en
[3] Stephen Hammer, *et al*, "Cities and Green Growth: A Conceptual Framework."
[4] Stephen Hammer, *et al*, "Cities and Green Growth: A Conceptual Framework."
[5] "Current and Projected Populations," *NYC Planning*, accessed January 11, 2017. https://www1.nyc.gov/site/planning/data-maps/nyc-population/current-future-populations.page.

counties do.[6] This is in part because of their proximity to both oceanic and inland waterways, allowing for easy access to trade routes and a variety of natural resources. Population along the U.S. coast is increasing, which leads to increased development in coastal cities and increased property value. With large and growing populations, cities have highly concentrated levels of property value and wealth. When sea levels rise, both the population and the accumulated wealth in coastal cities will be put at risk.

This thesis examines different governing structures to determine which is best for city-level SLRA. I combine two separate frameworks, my own theory framework and the framework for successful SLRA management created by experts in climate adaptation, by asking which of the governing structures listed in my theory framework is most effective for fulfilling the Georgetown Climate Center criteria. In this way, I find the governing structure most effective for SLRA management. I determine that limited-constraint autonomy, where the city controls most of its own SLRA projects, is most effective, but that multiple governing structures allow for successful SLRA planning.

Climate Change and Sea Level Rise

Ninety-seven percent of climate scientists across the globe believe that human behavior is causing an unprecedented shift in global climate patterns.[7] The term "climate change" encompasses all the unusual warming and cooling partners, flooding, droughts, storms, and atypical weather patterns caused by human behavior. Scientists have long understood the dangers of climate change, but only in the last few decades have countries begun to make widespread changes to combat the dangerous impact that unprecedented climate fluctuations will have on the

[6] Stephen Hammer, *et al*, "Cities and Green Growth: A Conceptual Framework."
[7] Fisher Stevens, *Before the Flood*, Film, directed Fisher Stevens (2016; National Geographic Channel.) Web.

earth's ecosystems.

From 1880 to 2012, the average global temperature rose 0.85°C.[8] According to the most recent Intergovernmental Panel on Climate Change (IPCC) reports, global temperature is likely to rise by between 1.5°C and 4.8°C by 2100.[9] Climate patterns have already shifted, proving that even a seemingly small temperature rise can lead to significant changes to earth's ecosystems; in the last few decades, flooding, droughts, storms, and unseasonal weather patterns have all increased in severity. These climate changes are the result of increasing anthropogenic greenhouse gas (GHG) emissions. GHGs, such as carbon dioxide and nitrous oxide, are naturally present in the atmosphere, but since the industrial revolution in the 1700s, humans have released unnatural levels of GHGs causing global temperatures to rise rapidly. Land and water absorb some sunlight when it reaches the Earth but the remaining, unabsorbed, sunlight reflects out into space in the form of infrared radiation. GHGs in the atmosphere trap some of this radiation. Trapped radiation helps the earth maintain baseline temperatures, but too much causes the earth's temperature to rise dangerously.[10]

Carbon dioxide, methane, and nitrous oxide are the primary GHGs emitted through human activity. Carbon dioxide, the most abundant of the three, is released whenever humans burn fossil fuels. Various ecological occurrences, including animal and plant respiration, release carbon dioxide naturally, but modern human behavior releases 30 billion extra tons of carbon dioxide into the atmosphere each year.[11] The Environmental Protection Agency (EPA) has stated that the "continued emissions of greenhouse gasses will lead to further climate changes. Future changes will likely include a warmer atmosphere, a warmer and more acidic ocean, higher sea

[8] IPCC Core Writing Team, *Climate Change 2014: Synthesis Report*, ed. Pachauri K. Rajendra and Meyer Leo (2015), accessed December 5, 2016, https://www.ipcc.ch/pdf/assessment-report
[9] IPCC Core Writing Team, *Climate Change 2014: Synthesis Report*.
[10] EPA, "Causes of Climate Change," accessed October, 31 2016. https://www.epa.gov/climate-change-science.
[11] EPA, "Causes of Climate Change."

levels, and larger changes in precipitation patterns."[12] These changes could prove devastating to all life on Earth. Humans can do little about the GHGs already emitted because GHGs stay in the atmosphere for long periods of time, continuing to cause weather patterns shifts for hundreds of years.[13]

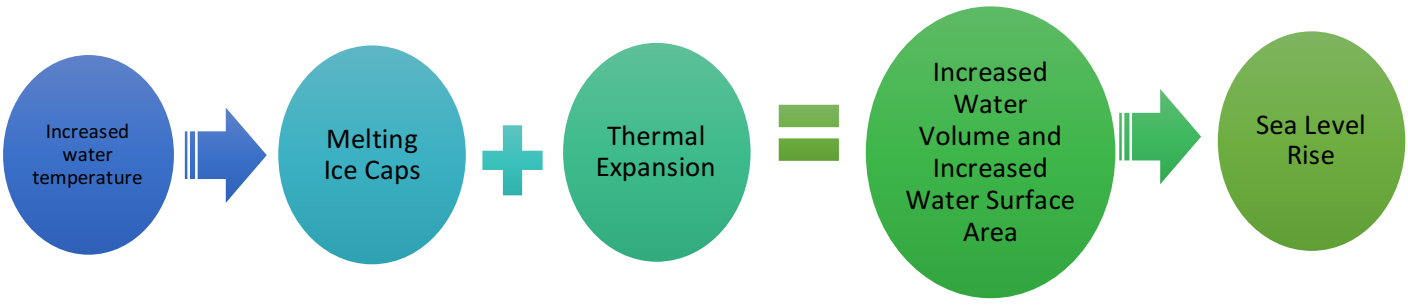
Any change to the Earth's climate patterns will impact the oceans, as they make up 71% of the Earth's surface and hold over 1.34 billion cubic kilometers of water.[14] The next largest supply of water comes from the polar ice caps and glaciers, which collectively hold 24 million cubic kilometers of water.[15] Though glaciers and polar ice caps only hold 1.74% of the Earth's water, compared to the ocean's 71%, their melting patterns significantly impact ocean sea levels.[16] As the earth's temperature rises, glaciers and ice caps melt at faster rates, causing sea levels to rise around the globe. According to NASA scientist Dr. Vivien Gornitz, shifts in melting patterns are nothing new; during periods of ice ages and subsequent deglaciations, sea levels have fluctuated between 390 and 460 feet between warmer and cooler periods over that last 800,000 years.[17] Though warming and cooling periods are natural, the current temperature trends are unlike any in the past 800,000 years. Atmospheric GHG levels have surpassed all known highs in the past 800,000 years, causing climate patterns to shift and sea level to rise more quickly than ever.

In her book, *Rising Seas: Past, Present, and Future*, Dr. Gornitz discusses the two primary causes of sea level rise: change in water volume and change in ocean size. Tectonic plate movement, ocean lava flows, and marine settlements cause changes in the actual size of

[12] EPA, "Future of Climate Change," accessed November 2016, https://www.epa.gov/climate-change-science/future-climate-change
[13] "Future of Climate Change." *EPA*, accessed November 2, 2016.
[14] Vivien Gornitz, *Rising seas: Past, Present, Future* (New York: Columbia UP, 2013) 3.
[15] Gornitz, *Rising seas: Past, Present, Future*.
[16] Gornitz, *Rising seas: Past, Present, Future*, 3.
[17] Gornitz, *Rising seas: Past, Present, Future*, 34.

ocean basins. Climate change primarily impacts the amount of water in the oceans, and does not generally impact the size of the ocean basins themselves. Climate change increases the amount of ocean water by raising water temperature.[18] As water temperatures rise, two events occur at the same time: water volume increases through thermal expansion and ice caps melt. Thermal expansion occurs when water expands because of an increase in temperature. This thermal expansion contributes to ice melting and sea level rise. Dr. Gornitz predicts that water temperature increases have led to a 1-millimeter rise in sea level across the globe each year.[19] These processes, melting ice caps and thermal expansion, add more water volume and surface area to the oceans. Increased surface area exposes more water to solar radiation, causing the ocean to heat up faster. As the water heats up, more ice melts, adding even more water to the ocean and increasing the surface area of the ocean even further.[20] Once started, this cycle is difficult to stop.

According to the Union for Concerned Scientists, a non-profit science research group, sea



[18] Gornitz, *Rising seas: Past, Present, Future*.
[19] Gornitz, *Rising seas: Past, Present, Future*.
[20] Gornitz, *Rising seas: Past, Present, Future*.

levels have already risen about eight inches since the Industrial Revolution.[21] Ten ice shelves have broken up in the Arctic Peninsula since the mid-1990s. In 1995, a 770-square mile ice shelf disintegrated in a month. In 2002, an Arctic ice shelf lost a total of 1,254 square miles in five days. Glaciers across the globe are shrinking, too. The glacier on Mount Kilimanjaro has decreased from 4.3 square miles in 1912 to under one square mile in 2008. Both the Rhone Glacier in Switzerland and the Athabasca Glacier in Canada have lost almost a mile since the late 1880s.[22] Most of this melting ice flowed into existing water sources, including the oceans. Combined with increased volume from thermal expansion, the average rise in sea levels is roughly 3.2 millimeters a year.[23]

This yearly rise of about 3.2 millimeters has caused an increase in ocean-related hazards, including flooding, severe storms, groundwater salinization, and loss of coastal wetlands. According to NASA, sea level rise, along with weather pattern shifts due to other climate change factors, could lead to an increased number of intense coastal storms.[24] Increased heat in the atmosphere and in surface level water increases wind speed, making hurricanes more dangerous. Along with increased storm intensity, sea level rise has led to saltwater intrusion into groundwater. When sea levels rise, salt water seeps into previously salt-free groundwater sources.[25] This can severely limit a coastal population's access to freshwater. Sea level rise also contributes to coastal erosion by destroying natural barriers, including beaches, cliffs, and marshes. Sea level rise both contributes to and is aggravated by this erosion. As natural barriers recede, water can move inland more easily, destroying land and homes. From 1998 to 2009, the

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[21] Rachel Cleetus, *Overwhelming Risk* (Union for Concerned Scientists, 2013), Accessed October 10, 2016.
[22] Gornitz*, Rising seas: Past, Present, Future*.
[23] Rebecca Lindsey, "Climate Change: Global Sea Level," *NOAA*, Last modified June 10, 2010, Accessed November 15, 2016.
[24] Holli Riebeek, "The Rising Cost of Natural Disasters," *NASA*, Last modified March 28, 2005, Accessed November 15, 2016. https://earthobservatory.nasa.gov/Features/RisingCost/rising_cost5.php
[25] Randall Abate, *Climate Change Impacts on Ocean and Coastal Law: U.S. and International Perspectives*, (Oxford, UK: Oxford University Press, 2015), Accessed 2016.

U.S. lost an area of wetlands roughly equivalent to the size of Rhode Island.[26] Land and home destruction from coastal erosion like this costs the U.S. roughly $500 million per year.[27]

At the current sea level rise rate, most coastal areas around the globe will flood beyond habitable levels by 2100, and low-lying coastal areas will flood substantially in the next twenty to thirty years. Some of this flooding will come from sudden onset storms, while most of the predicted sea level rise will come from a steady increase in water volume. While all coastal countries are at risk, this analysis will focus on the United States. The United States has roughly 12,000 miles of coastline, over 95,000 miles of shoreline, and more than 13,000 square miles of coastal wetlands.[28] By 2100, the amount of coastal area susceptible to significant flooding is expected to double along the Gulf Coast and Atlantic Coast, and the population in these high-risk zones is expected to increase by up to 140%.[29] General U.S. SLR predictions range from eight inches to almost seven feet.[30] NOAA, one of the most reputable reporters on SLR, predicts up to a 6.6 foot rise.[31] The Union for Concerned Scientist predicts that a two foot rise in sea level could cost the United States more than $1 trillion. Even a 50 cm rise by 2100 would cost anywhere from $20 billion to $150 billion, according to a report by the Pew Center on Global Climate Change.[32] Much of this financial risk comes from the large concentration of population-dense cities along the coastline. U.S. coastal land area holds roughly half of the U.S.

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[26] "U.S. Climate Resilience Toolkit," *Climate.gov*, accessed December 4, 2016, https://toolkit.climate.gov/
[27] "U.S. Climate Resilience Toolkit," *Climate.gov*.
[28] James E Neumann, Gary Yohe, Robert Nicholls, and Michelle Manion, "Sea Level Rise & Global Climate Change." *Pew Center on Global Climate Change*, Last modified 2000, Accessed November 10, 2016; "General Coastline and Shoreline Mileage of the U.S," *NOAA*, Accessed December 4, 2016. https://coast.noaa.gov/data/docs/states/shorelines.pdf
[29] Rachel Cleetus, *Overwhelming Risk.*
[30] Rebecca Lindsey, "Climate Change: Global Sea Level," *NOAA*, Last modified June 10, 2010, Accessed November 15, 2016.
[31] Rebecca Lindsey, "Climate Change: Global Sea Level."
[32] James E Neumann., Gary Yohe, Robert Nicholls, and Michelle Manion, "Sea Level Rise & Global Climate Change."

population.[33] Roughly 164 million Americans live in counties along the coast and at least 25 million of those people live in designated flood risk zones.[34]

NOAA projects that the U.S. coastal population will grow by 10 million between 2010 and 2020.[35] In 2010, the average population density of coastal counties was 446 people per square mile. Also in 2010, 35% of the white American population, 47% of the African American population, 64% of the Asian population, and 49% of the Latino population lived along the coast.[36] These percentages are expected to grow in coming years, following recent trends. Between 1980 and 2010, for example, the Latino population living in coastal counties increased by 211%.[37] The population along the Atlantic, Pacific, and Gulf Coasts increased by 40 million between 1960 and 2008.[38] During that same time frame, the population density along the coasts went from 250 people per square mile in 1960 to almost 500 per square mile, and the number of housing units along the coasts went from about 16.1 million to 36.3 million.[39]

These coastal communities typically experience rising and falling tides at a steady rate. During a given year, following the cycle of the moon, tides will either be lower than average or higher than average. Increased sea levels have led to frequent and longer-lasting flooding, according to a report by the Union of Concerned Scientists.[40] Tidal flooding can damage homes,

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[33] James E Neumann, Gary Yohe, Robert Nicholls, and Michelle Manion, "Sea Level Rise & Global Climate Change."
[34] "Climate Impacts on Coastal Areas," EPA, Accessed December 4, 2016; "National Climate Assessment," U.S. Global Change Research Program, last modified 2014. Accessed December 4, 2016.
[35] NOAA,"National Coastal Population Report Population Trends from 1970 to 2020,"Last modified 2013, Accessed January 4, 2017.
[36] NOAA,"National Coastal Population Report Population Trends from 1970 to 2020,"
[37] NOAA,"National Coastal Population Report Population Trends from 1970 to 2020,"
[38] Rachel Cleetus, *Overwhelming Risk.*
[39] Rachel Cleetus, *Overwhelming Risk.*
[40] Erika Spanger-Siegfried, Melanie Fitzpatrick, and Kristina Dahl, "Encroaching Tides." *Union of Concerned Scientists*, 2014. Accessed January 4, 2017. http://www.ucsusa.org/sites/default/files/attach/2014/10/encroaching-tides-full-report.pdf

infrastructure, and resources. Communities need to adapt to increased tidal flooding due to sea level rise. The United States has infrastructure in place to handle storm-induced flooding but has limited infrastructure related to slow, climate change induced, flooding from sea level rise.

Federal Flood Policy

The Federal Emergency Management Agency (FEMA) and the corresponding National Flood Insurance Program (NFIP) are the primary federal mechanisms available to combat the effects of sea level rise in the United States. FEMA, created in 1979, exists to "support… citizens and first responders to ensure that as a nation we work together to build, sustain and improve our capability to prepare for, protect against, respond to, recover from and mitigate all hazards."[41] FEMA developed from several pre-existing agencies: The National Fire Prevention and Control Administration of the Commerce Department, the National Weather Service Community Preparedness Program, the Federal Preparedness Agency of the General Services Administration, and the Federal Disaster Assistance Administration and Federal Insurance Administration of HUD.[42] FEMA provides various grants to state governments for disaster prevention and disaster relief. The grants for flood prevention and relief are based in part on FEMA flood maps, which outline areas in coastal and riverine counties that are at risk of flooding. FEMA uses these maps in its National Flood Insurance Program (NFIP), which provides flood insurance for homeowners in at-risk flood flooding. The NFIP was established in 1968 in response to massive damage by Hurricane Betsy, which hit Louisiana in 1965. The goals of the program included providing affordable flood insurance and to limiting the need for

[41] "About the Agency," *FEMA,* Accessed November 15, 2016.
[42] "The Federal Emergency Management Agency," *FEMA*, Last modified 2010, Accessed November 10, 2016.

taxpayer-funded flood management relief.[43] The NFIP defines a "flood" as

> "A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is your property) from overflow of inland or tidal waters, from unusual and rapid accumulation or runoff of surface waters from any source, or from mudflow."[44]

This definition applies to climate change induced sea level rise. The NFIP provides coverage for flooding from any inland or tidal water. Inland floods include floods from non-ocean bodies of water, such as lakes and rivers. Throughout this paper, when I refer to numbers of NFIP policyholders in general, I am referring to policyholders impacted by either inland or tidal floods, or both. When I refer to policy holders in coastal zones, I only refer to homeowners impacted by tidal floods.

As a branch of FEMA, NFIP relies on FEMA mapping data to determine insurance costs. FEMA maps categorize coastal areas based on their flood risk. The highest risk zones, called Special Flood Hazard Areas, or SFHAs, have a one in four chance of flooding within a thirty-year period. Often referred to as the "100 year flood" zones, these areas have a greater than one percent chance of flooding in any given year.[45] These zones are marked on flood maps as "A" and "V" zones."[46] Moderate flood hazard zones have a 0.2 percent chance of flooding on any given year. These are marked as "B" and shaded "X" zones.[47] The lowest category, minimal flood hazard zones, have less than a 0.2 percent chance of flooding each year.[48] These are

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[43] Rachel Cleetus, *Overwhelming Risk.*
[44] "Answers to Questions about the NFIP," *FEMA,* Last modified 2011, Accessed December 28, 2016. https://www.fema.gov/media-library-data/20130726-1438-20490-1905/f084_atq_11aug11.pdf
[45] "How to Read a FIRM Online Tutorial," *FEMA*, Accessed December 28, 2016, https://www.fema.gov/media-library/assets/documents/7984.
[46] "Definitions of FEMA Flood Zone Designations," *FEMA Map Service Center*, Accessed December 28, http://snmapmod.snco.us/fmm/document/fema-flood-zone-definitions.pdf2016.
[47] "Definitions of FEMA Flood Zone Designations," *FEMA.*
[48] "Understanding Your Risk," *FEMA*, Accessed November 19, 2016, http://snmapmod.snco.us/fmm/document/fema-flood-zone-definitions.pdf

marked as "C" and unshaded "X" zones.[49] Areas with undetermined levels of risk are marked as "D" zones.[50]

The highest risk zones have a 1% chance of flooding in a given year. FEMA chose this standard because it "constitute[d] a reasonable compromise between the need for building restrictions to minimize potential loss of life and property and the economic benefits to be derived from floodplain development."[51] As a compromise between safety and economic benefit, the 100-year floodplain is a minimum standard. Any home or building in a high risk zone has *at least* a 1% chance of flooding in a given year. With the rapid changes in climate patterns, that FEMA designation of a 1% chance should be taken as a base standard instead of as a certainty.

In an October 2012 Summary of Coverage, the NFIP described flood insurance as "Single-peril policy that pays for direct physical damage to your insurance property up the replacement cost or Actual Cash Value (ACV) of the actual damages of the policy limit of liability, whichever is less."[52] NFIP offers two insurance options, Building Property coverage and Personal Property coverage. Landowners may choose one or both plans. The Building Property plan does not cover the contents of a building, only the actual property itself, nor do they cover the actual value of a building. Neither plan covers the total value of damaged property, and instead cover the replacement cost or ACV up to the policy limit. The replacement cost to damaged property is often less than the value of the property itself. Neither plans fully covers replacement cost if the replacement cost is over the set maximum of the given insurance plan. Building Property plans cover a given building, its foundation, electrical and plumbing system, heating and cooling systems, garages, built in appliances, and permanent flooring,

[49] "Definitions of FEMA Flood Zone Designations," *FEMA.*
[50] "Definitions of FEMA Flood Zone Designations," *FEMA.*
[51] "Answers to Questions about the NFIP," *FEMA.*
[52] "Summary of Coverage," *FEMA,* Last modified October 2012, Accessed January 2, 2017. https://www.fema.gov/media-library-data/20130726-1620-20490-4648/f_679_summaryofcoverage_11_2012.pdf

bookcases, panels, and cabinets.[53] Personal Property coverage insures personal belongings within the building, curtains, portable appliances, non-permanent carpets, and some valuable items up to $2,500.[54]

If a state, area, political subdivision, Native American Tribe, or Alaskan native village adopts and enforces a floodplain management strategy in accordance with FEMA maps and NFIP policy, then homeowners in SFHAs are required to purchase flood insurance. As of 2016, all fifty states have communities covered by NFIP and some tribal territories are covered by NFIP.[55] Communities without clear floodplain management strategies cannot participate in NFIP, and federally regulated insurance agencies are forbidden from providing flood insurance in those areas.[56] The details for NFIP compliance are listed in Title 44, Chapter 1 of the U.S. Code of Federal Regulations (CFR). Under the CFR:

> "If a subdivision proposal or other proposed new development is in a flood-prone area, any such proposals shall be reviewed to assure that (i) all such proposals are consistent with the need to minimize flood damage within the flood-prone area, (ii) all public utilities and facilities, such as sewer, gas, electrical, and water systems are located and constructed to minimize or eliminate flood damage, and (iii) adequate drainage is provided to reduce exposure to flood hazards."[57]

It is possible to participate in NFIP without FEMA flood maps. Under the same act, NFIP coverage is allowed when:

> "The Federal Insurance Administrator has not defined the special flood hazard areas within a community, has not provided water surface elevation data, and has not provided sufficient data to identify the floodway or coastal high hazard area, but the community has indicated the presence of such hazards by submitting an application to participate in the Program."[58]

If a community does not have a map because the local flood plains are too small to

[53] "Summary of Coverage," *FEMA*.
[54] "Summary of Coverage," *FEMA*.
[55] "Federal Emergency Management Agency Community Status Book Report," *FEMA*, Last modified December 19, 2016, Accessed December 28, 2016, https://www.hsdl.org/?view&did=12387
[56] "Joining the National Flood Insurance Program," *New York State*, Accessed January 18, 2017.
[57] 44 U.S. CRF ch. 1 § 60.3 (a) (4) (1976).
[58] 44 U.S. CRF ch. 1 § 60.3 (a) (1976).

warrant a FEMA map, those areas are treated as C and X Zones.[59] If a community has independent flood zone regulations stricter than those that FEMA provides, communities are encouraged to base decision-making on that data instead. The CFR says, "Any floodplain management regulations adopted by a State or a community which are more restrictive than the criteria set forth in this part are encouraged and shall take precedence."[60]

Communities participating in the NFIP can participate in the voluntary Community Rating System (CRS), which provides incentives for communities to go beyond basic NFIP requirements. According to a May 2016 fact sheet explaining the purpose and effectiveness of the CRS: "Under the CRS, flood insurance premium rates are discounted to reward communities actions that meet the three goals of the CRS, which are (1) reduce flood damage to insurable property; (2) strengthen and support the insurance aspects of the NFIP; and (3) encourage a comprehensive approach to floodplain management."[61] Communities granted CRS membership have lower flood insurance premiums, access to CRS trainings, and no-cost technical assistance in designing flood management programs.[62] As of May 2016, only 5% of the over 22,000 communities participating in NFIP were members of the CRS. Though CRS communities make up a small percentage of the total NFIP-covered communities, CRS communities hold 69% of all NFIP flood insurance policies.[63]

Though flood insurance is mandatory for homes in the highest risk zones, the Union for Concerned Scientists estimates that only eighteen percent of homes in risk zones have flood insurance. This number implies that homeowners in moderate and low risk areas do not tend to

[59] "Flood Maps." *FEMA*, last modified May 1, 2008, Accessed January 18, 2017.
[60] 44 U.S. CRF ch. 1 § 60.1 (d) (1984).
[61] "Federal Insurance and Mitigation Administration- Fact Sheet," *FEMA*, May 2016, Accessed January 18, 2017, https://www.fema.gov/media-library-data/1464356203875-13a7afa1f593a3f137f5855b784498fa/FIMA_Overview_Fact_Sheet_2016r.pdf
[62] "Federal Insurance and Mitigation Administration- Fact Sheet," *FEMA*.
[63] "Federal Insurance and Mitigation Administration- Fact Sheet," *FEMA*.

purchase flood insurance. It also implies that most homeowners live outside of the SFHAs because if flood insurance is mandatory in SFHAs and only 18% of homeowners in risk zones own flood insurance, most of the homes in risk zones must be in moderate and low risk areas.

Congress has gone back and forth between attempting to broaden FEMA and NFIP's reach and limiting their reach. To expand federal aid in moments of disaster, under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, which was signed into law in 1988 and amended in 2013, Congress broadened the scope of disaster relief programs, including FEMA and NFIP. In the initial section of the act, Congress wrote:

> "Because disasters often disrupt the normal functioning of governments and communities, and adversely affect individuals and families with great severity; special measures, designed to assist the efforts of the affected States in expediting the rendering of aid, assistance, and emergency services, and the reconstruction and rehabilitation of devastated areas, are necessary."[64]

Under a related act, the Biggert-Waters Flood Insurance Reform Act of 2012, Congress recognized some of the NFIP's shortcomings and mandated that overall premium rates rise. The act reauthorized NFIP to last through 2017 and required that premiums begin to rise in 2013 to better reflect risk.[65] Despite the rise in insurance premiums, as of 2016, neither insurance premiums nor flood maps accurately reflect risk in certain areas. Without including data on the likelihood of flooding and projected flood heights, and without analyzing future risk as well as current risk, the FEMA maps and corresponding NFIP are insufficient for assessing real SLR risk.

There are two crucial problems with the way FEMA and NFIP flood management systems address climate change induced sea-level rise. First, NFIP does little to discourage building in high-risk flood zones, and second, the FEMA maps primarily reflect current risk

[64] "Robert T. Stafford Disaster Relief and Emergency Assistance Act," *FEMA*, Accessed December 4, 2016, https://www.fema.gov/robert-t-stafford-disaster-relief-and-emergency-assistance-act-public-law-93-288-amended
[65] Rachel Cleetus, *Overwhelming Risk.*

instead of focusing on future risk. These two problems are related, as NFIP policies rely on FEMA maps. Current FEMA maps list areas that are likely to experience flooding, but the maps do not consider all aspects of sea level rise, like erosion and actual data about how high tidal floods will rise. FEMA maps determine risk areas, but do not mention when floods will occur or how high those floods will be; this is crucial information for city planners making SLRA decisions. A 2013 Government Accountability Office (GAO) report found that Congress had not given FEMA or NFIP authorization to account for long-term coastal erosion when creating the new maps.[66] Coastal erosion is a key factor in determining the severity of future sea level rise. Rising tides contribute to erosion, and once natural barriers have eroded, tides can move inward more quickly and reach more ground. As long as FEMA maps do not take coastal erosion or flood height into account in their analysis of flood risk, they will remain inaccurate.

Over the last several years, FEMA has updated many of its flood maps across the country. This is an important step towards increasing general awareness of risk, but not all new maps reflect future risk. New York City, which I will discuss in more detail later, has requested that FEMA limit the scope of its NYC flood map to reflect a minimal level of risk. Sea level rise poses serious risk to homeowners in flood-prone areas, so any map that does not accurately reflect risk puts homeowners in danger. FEMA lacked funding to update maps up until Hurricane Sandy hit in 2012. After Hurricane Sandy, FEMA made updating the flood risk maps for New York and New Jersey a high priority. The new maps released in the last several years do reflect that areas further away from the coast are at risk. While the inclusion of risk in further inland areas is a step towards demonstrating true risk levels, the maps still do not account for the long-term impacts of climate change on sea level rise.

Any inaccuracies or inadequate risk evaluation in the maps is reflected in insurance rates.

[66] GAO, *High Risk Series: An Update*, (Washington, D.C.: GAO, 2013).

The Union for Concerned Scientists poses a problem with the current insurance rates: the NFIP's ability to provide low-cost insurance does not reflect true risk, encouraging homeowners to continue to purchase homes in high-risk areas. Higher premiums would more accurately reflect the risk assumed when purchasing a home in a high-risk flood zone.[67] Even when FEMA publishes updated flood maps, NFIP insurance rates are still offered at rates consistent with previous maps. The NFIP "Grandfather Rule" allows homeowners to apply for lower insurance rates that are based on previous maps if the home in question was built after the first ever flood map was published and the homeowner purchased insurance between the publishing of the previous map and the release of the new map.[68] This rule allows homeowners to continue to purchase insurance that does not accurately reflect risk. If a homeowner in a higher risk zone can purchase insurance priced at a lower-risk rate, the homeowner will remain in the area and stay at risk. If NFIP insurance rates were high and reflected true risk, homeowners might move out of the area or decline to move to a high risk zone at all.

When the Biggert-Waters Act was amended under the Homeowner Flood Insurance Affordability Act (HFIAA), grandfather clauses were cemented in FEMA policy. The 2014 passage of the HFIAA took away Section 207 of the Biggert-Waters Act which had required that FEMA increase insurance rates for homes moved into higher-risk zones during remapping.[69] The Biggert-Waters Act had required FEMA to phase out previously existing grandfather policies, but FEMA had not begun phasing them out by the time of HFIAA's passage.

NFIP is able to provide lower insurance rates by borrowing from the U.S. Treasury. Along with encouraging buyers to purchase homes in high-risk areas, low premiums prevent

[67]Rachel Cleetus,*Overwhelming Risk.*
[68] "Grandfathering for Property Owners," *FEMA*, Last modified September 27, 2016. Accessed December 4 2016.
[69] GAO, *Status of FEMA's Implementation of the Biggert-Waters Act, as Amended, (*Washington, D.C.: GAO, 2015), Accessed January 18, 2017.

NFIP from collecting enough money to adequately cover damages incurred during disasters. When Hurricanes Katrina, Rita, and Wilma hit in 2005, they cost the NFIP $21.9 billion in damages. This high cost left the NFIP $17.5 billion dollars in debt, forcing it to borrow more from the U.S. Treasury.[70] Hurricane Sandy caused another increase in NFIP debt in 2012. Within three months after the Hurricane Hit, the NFIP received between $12 billion and $15 billion in insurance claims. In response, Congress increased the NFIP's Treasury borrowing cap from $20.7 billion to $30.4 billion.[71] The billions of dollars in damage claims came from the only fifteen to twenty-five percent of at-risk homes insured under the NFIP. Nationally, only about eighteen percent of homes in flood risk zones have NFIP insurance because only homes in high-risk zones are legally required to purchase insurance.[72] Without widespread insurance coverage at premiums that accurately reflect risk, buyers will continue to buy homes in at-risk zones and the NFIP will continue to accrue debt when disasters hit.

Based in part on the flood risk maps, FEMA provides grants for states to improve their flood management responses. States have used these grants to both repair after floods and to prepare for future floods. FEMA provides grants under its Hazard Mitigation Assistance Program (HMA). HMA developed in response to a 2009 Executive Order from President Obama requiring federal programs to take GHG emissions into account in policy-making efforts.[73] Executive Order 13693 revoked and updated the 2009 order by expanding the initial order beyond limiting GHG emissions.[74] Within the HMA Program, FEMA administers three sub-

[70]Marc Landy, "Adapting to Climate Change: Problems and Prospects." Compiled by Barry Rabe. In *Greenhouse Governance: Addressing Climate Change in America*, (Washington, D.C.: Brookings Institution Press, 2010), 204-26.
[71] Rachel Cleetus, *Overwhelming Risk.*
[72] Rachel Cleetus, *Overwhelming Risk.*
[73] "Exec. Order No. 13514, 3 C.F.R. (2009).
[74] "Executive Order -- Planning for Federal Sustainability in the Next Decade," *The White House*, last modified March 19, 2015, Accessed November 29, 2016, https://obamawhitehouse.archives.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade

programs, the Hazard Mitigation Grant program (HMPG), the Flood Mitigation Assistance program (FMA), and the Pre-Disaster Mitigation program (PDM).

The HMPG program provides grants to communities following a presidential declaration of a major disaster. The program is designed for use by states, tribal, and local governments attempting to engage in climate change hazard mitigation.[75] No non-governmental or non-tribal organization can apply directly for an HMPG grant. FEMA requires that homeowners, businesses, and private nonprofits apply for funding through state agencies, recognized tribes, HMGP recognized nonprofits, tribal agencies, and local governments. Of these groups, only states, local governments and territories, and federally recognized tribes may directly submit grant applications to FEMA.[76] Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, FEMA requires any state, tribal government, and local government to have a long-term hazard mitigation strategy Grants are only given to programs that fit in the applicant's FEMA-approved hazard mitigation strategy. No state may receive more than fifteen percent of the total amount of disaster grants, and each state must match the grant at twenty-five percent.[77]

HMPG funding is ineffective for sea level rise adaptation projects because it is only available after a disaster has already occurred. Sea level rise adaptation projects must be preemptive. PDM grants also do not cover preemptive flood related projects, as FEMA expects all flood related projects to receive funding through FMA.[78] FMA funding, authorized under the National Flood Insurance act of 1968 as part of NFIP, "provides funding to States, Territories, federally-recognized tribes and local communities for projects and planning that reduces or

[75] "Hazard Mitigation Grant Program" *FEMA*, Accessed November 29, 2016, https://www.fema.gov/hazard-mitigation-grant-program
[76] "Hazard Mitigation Grant Program" *FEMA*.
[77] "Hazard Mitigation Grant Program" *FEMA*.
[78] "Pre-Disaster Mitigation Grant Program," *FEMA*, Last modified November 9, 2016, Accessed December 4, 2016. https://www.fema.gov/pre-disaster-mitigation-grant-program

eliminates long-term risk of flood damage to structures insured under the NFIP."[79] Only states, local governments and territories, and recognized tribes may apply directly to FEMA for FMA grants. Applications are accepted all year, and do not depend in any part on whether the President declares a state of disaster. In Fiscal Year 2016 (FY16), the total FMA grant amount reached $199,000,000. FY16 applicants could receive up to $100,000 in total.[80]States use FEMA grants and FEMA flood maps to develop and implement their own policies.

FEMA requires that states have hazard mitigation plans in place, but the specifics of the plans are up to the states. Neither the federal government nor the individual states have fully effective sea level rise adaptation mechanisms, in part because climate-change induced sea level rise is a relatively new concept. FEMA and NFIP provide starting points to build more concrete sea level rise adaptation policies, but there are key flaws in their current approaches to flood management: NFIP does little to discourage building in high-risk flood zones and the FEMA maps primarily reflect current risk. If FEMA maps focus on current risk instead of future risk, states will continue to avoid implementing future-looking hazard mitigation plans.

A city must adhere to NFIP policy for its residents to obtain NFIP coverage, but if basic NFIP requirements are covered, cities and states can use other data sources to enact SLRA policy that is future-looking. Cities and states engaging in SLRA have the choice whether to use FEMA data as a basis for their adaptation decisions. This section has laid out the shortcomings of FEMA maps and the shortcomings of NFIP policies; FEMA maps only show which areas are likely to flood and do not take future risk into account by considering erosion, while NFIP policies do little to discourage building in at-risk areas. Other data sources, like those from

[79] "Flood Mitigation Assistance Grant Program," *FEMA*, Last modified, August 30, 2016, Accessed December 3, 2016, https://www.fema.gov/flood-mitigation-assistance-grant-program#.
[80] "FY 2016 Flood Mitigation Assistance (FMA) Grant Program," *FEMA*. Accessed December 4, 2016, https://www.fema.gov/media-library-data/1455710459301-048a67862580037b30cd640a802a9053/FY16_FMA_Fact_Sheet.pdf

NOAA and various research institutions, provide more comprehensive and future-looking data sets that cities and states can use when engaging in SLRA.

Alternative Data Sources

While FEMA is the primary data source for flood insurance, several other organizations and federal agencies research sea level rise across the United States. The National Oceanic and Atmospheric Administration (NOAA), an agency within the U.S. Department of Commerce, studies climate patterns, oceans and coasts, weather, fisheries, and various other ecosystems.[81] Under its coastal and ocean research, NOAA provides tidal bulletins, tide predictions, real-time tide data, historic tide data, sea level rise maps, current sea level data, and sea current data.[82]

NOAA provides three interactive SLR related maps online: The Coastal Flood Exposure Mapper, the Sea Level Rise and Coastal Flooding Impact map (SLRCFI), and the Sea Level Trends map. The Coastal Flood Exposure Mapper (CFEM) shows shallow coastal flooding data, FEMA flood zones, storm surge data, and the reach of tides with different SLR scenarios.[83] This resource also notes population density, poverty levels, critical facilities, pollution sources, open spaces, and projected population growth in coastal areas.[84]

The Sea Level Trends map shows mean sea level heights per year and shows the change in sea level height over the last few decades.[85] The SLRCFI map allows users to view SLR

[81] "Our Work," *NOAA*, Accessed January 22, 2017, http://www.noaa.gov/our-work
[82] "Where do I get NOAA tides and currents data?" *NOAA,* Last modified December 8, 2016, Accessed January 22, 2017. http://oceanservice.noaa.gov/facts/find-tides-currents.html
[83] "Coastal Flood Exposure Mapper," *NOAA*, Accessed January 22, 2017, https://www.coast.noaa.gov/floodexposure/#/map
[84] ""Coastal Flood Exposure Mapper," *NOAA*.
[85] "Sea Level Trends," *NOAA*, Last modified October 15, 2013, Accessed January 22, 2017, https://tidesandcurrents.noaa.gov/sltrends/sltrends.html

scenarios for 0-6 ft of SLR above the mean high high water mark (MHHW).[86] MHHW is the average of high water tides in an area.[87] The map notes how far high tides would reach depending on sea level heights. NOAA includes the rise above MHHW because "[the MHHW] represents the elevation of the normal daily excursion of the tide where the land area is normally inundated. Taking this normal extent of inundation into account is important when trying to delineate land areas inundated by abnormal events such as storm surge, tsunami run-up, or sea level change."[88]

The map is updated periodically, based on consideration of the quality and extent of new data.[89] The map does have shortcomings. The data in the map does not consider erosion or marsh migration. The maps also do not fully capture local water systems and stormwater infrastructure, including canals and ditches.[90] The map also does not include the timing of SLR. NOAA has mapped all states and territories except Alaska because there is not enough coastal elevation data for the state. This mapping system is slightly more effective for SLRA planning than FEMA maps are because, though it does not map Alaska and shares some limitations with the FEMA maps, it does demonstrate what different levels of SLR will look like, allowing policy makers to take exact flood heights into account.

States and cities can decide whether to use these alternative data sources when making SLRA decisions. All cities that use NFIP adhere to FEMA mapping regulations to determine flood hazard areas, but cities do not have to use FEMA data to determine risk zones for SLRA

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[86] Sea Level Trends," *NOAA.*
[87] "Glossary." *NOAA Shoreline Website*, Last modified May 9, 2016, Accessed January 22, 2017, https://shoreline.noaa.gov/glossary.html
[88]"Frequent Questions: Digital Coast Sea Level Rise and Coastal Flooding Impacts Viewer*." NOAA Office for Coastal Management*, Last modified December 2015, Accessed January 22, 2017.https://coast.noaa.gov/data/digitalcoast/pdf/slr-faq.pdf
[89] Frequent Questions: Digital Coast Sea Level Rise and Coastal Flooding Impacts Viewer*." NOAA Office for Coastal Management.*
[90] "Sea Level Rise and Coastal Flooding Impacts." *NOAA*.

purposes. In fact, FEMA data is not entirely helpful for SLRA. FEMA data shows what areas are at risk of flooding, but does not note how much flooding will occur or when that flooding will occur.

Successful Sea Level Rise Preparedness

In 2011, The Georgetown Climate Center (GCC) released a report, titled "Adaptation Tool Kit: Sea-Level Rise and coastal Land Use," outlining the different ways cities could plan for SLR. NOAA promotes the report as a framework for evaluating SLRA effectiveness on its website, the U.S. Climate Resilience Toolkit.[91] This report uses data from the IPCC and NOAA, both reputable sources with data points that consider both current and future SLR risk. I will use the criteria for effective adaptation laid out in this report as a framework to evaluate the strategies described in my case studies. I will use the GCC list to evaluate the effectiveness of the SLRA management in each of my case studies. It is impossible to determine the effectiveness of the actual SLRA mechanisms, including sea walls and drainage systems, as they have yet to be put to the test. These adaptive mechanisms will only be tested once the sea levels rise a certain amount, or if a hurricane hits and causes coastal flooding.

The report suggests that to prepare for SLR, local governments need to develop comprehensive plans. The GCC considers fulfillment of the following criteria necessary for successful SLRA planning:

- "Establish the degree of SLR and time period to be considered when making land-use decisions (e.g., one foot by 2035).
- Study and identify potential SLR impacts (e.g., erosion, flooding, high wind, wave action, and storm surge).

[91] "U.S. Climate Resilience Toolkit," *Climate.gov* Accessed March 15, 2017. https://toolkit.climate.gov/tool/adaptation-tool-kit-sea-level-rise-and-coastal-land-use

- Assess vulnerabilities (by area, number, and type of structures, occupancies, and types of impacts).
- Designate areas requiring special protection (such as wetlands, beaches, and floodplains). For example, planners can designate "retreat zones" where landowners could be subject to limits on armoring and rebuilding.
- Site future public infrastructure outside of vulnerable areas (such as roads and water treatment facilities).
- Identify the specific land-use tools that will be used to respond to SLR threats in different areas.
- Create a schedule for implementation"[92]

Instead of evaluating the effectiveness of the physical adaptive mechanisms, I will use this list of criteria from the GCC to evaluate the effectiveness of SLRA preparedness. Each criterion is specific and measurable. For example, either a city designates protected areas or it does not. The broadest of the criteria is the identification of land-use tools. Land-use tools refer to anything from zoning, floodplain management laws, building codes, building restrictions, and the development of physical barriers to SLR.[93]

As a reputable organization that helps governments develop climate policy, the GCC provides the most detailed checklist for SLRA preparedness that I could find. This is an appropriate evaluative framework both because of its level of detail and because it is designed to apply to either states or cities, as opposed to the federal government. It also considers basic preparedness questions, like awareness of risk zones and baseline SLR heights. It is necessary to consider a city's basic level of preparedness to determine how well it will handle SLRA management in the future. I will combine this framework with my categorical framework to determine which governing structures best allow for successful completion of the GCC criteria.

[92]Jessica Grannis, "Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use How Governments Can Use Land-Use Practices to Adapt to Sea-Level Rise*,"* Georgetown Climate Center (2011), Accessed March 15, 2017. http://www.georgetownclimate.org/files/report/Adaptation_Tool_Kit_SLR.pdf.
[93] Jessica Grannis, "Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use How Governments Can Use Land-Use Practices to Adapt to Sea-Level Rise*."*

Theory: Different Governing Structures for Adaptation

This section will address multiple ways in which cities and states either work together or separately to enact sea level rise adaptation policies. Political theories about environmental regulation tend to focus on the relationship between the state government and the federal government. By applying concepts from theories about state-federal relationships in emission reduction to theories about cities' roles in SLRA, I develop my own four categories of city-focused climate management within a federalist system.

My four categories developed out of a combination of inductive and deductive processes. I started my research with four categories of state-federal relationships in mind; these four categories came from Barry Rabe and Martha Derthick. When I dug into my research, however, I realized that these categories about state-federal relationships did not fit the reality of SLRA. I found that most SLRA in the U.S. started at the city level. Using concepts from Rabe and Derthick's categories, which I explain below, I created my own four categories of city autonomy in SLRA policy making. After researching multiple cities' SLRA efforts, I found four distinct types of city-state-federal interaction in SLRA: city led, state led collaborative policy making, and instances where city and state policies conflicted.

In his piece *Contested Federalism and American Climate Change Policy*, Barry Rabe posits four theories applicable to the federal-state relationship in sea level rise adaptation: total preemption, bargained preemption, partial preemption, and collaborative federalism. The preemption categories all involve ways the federal government controls state action, while collaborative federalism focuses on how the two levels of government can both influence policy development.

In instances of total preemption, Congress controls both policy making and policy compliance. This type of federal domination occurs in many policy arenas, not just environmental policy, and is often done to set a uniform standard across the country. A 1992 U.S. Advisory Commission on Intergovernmental Relations (ACIR) defines total preemption as when "the federal government assumes complete regulatory authority."[94] Rabe's next theory, bargained preemption, involves specific restrictions or qualifications set at the federal level that are less restrictive than those set in total preemption situations. Rabe describes bargained preemption where "the federal government can either negotiate terms directly with states or embrace their most ambitious efforts as a national standard."[95] This bargaining can take the form of legal agreements, regulatory mandates, and financial incentives. Rabe cites the Climate Security Act as a clear example of bargained preemption; the act allowed states that highly reduced GHG emissions to receive financial benefits if they abstained from launching their own cap-and-trade programs. Rabe defines the third preemption category, partial preemption, as when the federal government sets a national baseline standard. In partial preemption situations, if states adhere to the baseline standard, they can institute any chosen policies to maintain adherence. The U.S. ACIR defines partial preemption in the following way:

> "Under partial federal preemption, the Congress or federal administrative agencies may establish minimum national standards for a function or service and authorize the states to exercise primary regulatory responsibility, provided the state standards are at least as high and are enforces. Partial preemption permits a state to tailor regulatory programs to meet special needs and conditions."[96]

[94] Advisory Commission on Intergovernmental Relations, *Federal Statutory Preemption of State and Local Authority: History, Inventory, and Issues*, published 1992, accessed December 29, 2016.
[95] Barry Rabe, "Contested Federalism and American Climate Policy," *Publius: The Journal of Federalism* 41, no. 3 (2011), Page 509.
[96] Advisory Commission on Intergovernmental Relations, *Federal Statutory Preemption of State and Local Authority: History, Inventory, and Issues.*

Partial preemption allows states to continue using their own policies if they comply with federal standards. Partial preemption, then, is the least restrictive form of Rabe's three theories of preemption.

Rabe's fourth category, collaborative federalism, is defined as "an ongoing intergovernmental partnership rather than a formal distribution of power as would exist under total or partial preemption."[97] Defined in terms of emission reduction projects, collaborative federalism occurs when the overall framework of specific emission levels and expectations is maintained by the federal government, while the states maintain control over policy development to reach the overarching goals set through negotiations at both levels. Instead of creating an overarching standard applicable to all states, like in partial preemption, the federal government negotiates with states to create state-specific goals. The federal government then has the capacity to measure the success of a given state's chosen policies. Unlike with bargained preemption, the states are not frequently held accountable through financial incentive or threat of resource withdrawal.

Total Preemption	**Bargained Preemption**	**Partial Preemption**	**Collaborative Federalism**
The federal government sets uniform standards and monitors state compliance	The federal government negotiates with states to set a standard. The federal government then enforces compliance.	The federal government requires that states adhere to a baseline standard. States can adopt any policy that fits the standard.	The federal government sets an overarching goal, but policy decision-making power lies with the states. The federal goal does not include a uniform standard across states.

[97] Barry Rabe, "Contested Federalism and American Climate Policy," 513.

In an article titled *Compensatory Federalism*, Martha Derthick, a renowned political theorist with a focus on federalism, introduces another way of thinking about the federal-state relationship in environmental governance. Compensatory federalism is the idea that it is the job of the states to fill in the gaps in federal policies. Derthick writes "federalism works when governments at one level for the system are able to compensate for weaknesses or defects at another level."[98] Federal statutory commands may be unrealistic and, oftentimes, state governments work through policy decision-making processes faster than the federal government does.[99]

Compensatory state actions in the environmental arena are often necessary. In 2003, New York governor, George Pataki, asked neighboring states to join New York in creating a regional cap and trade system for carbon emissions, separate from any federal program. This program was successful; by 2007, it had turned into the Regional Greenhouse Gas Initiative (RGGI) which included Connecticut, Delaware, Maine, New Hampshire, New York, Vermont, Maryland, Massachusetts, and Rhode Island.[100]

Though all the theories mentioned so far apply to state-federal relationships, they can be edited to apply to questions of city governance. Like a state, a city can conflict or comply with the federal government. The city can also conflict or comply with the state. This tri-layered governance system, involving the city, the state, and the federal government, is an example of "multilevel environmental governance." In his book, *Multilevel Environmental Governance: Managing Water and Climate Change in Europe and North America*, Ingber Weibust describes multilevel governance (MLG) in environmental policy. Multilevel governance "is used as a

[98]Martha Derthick, "Compensatory Federalism," In *Greenhouse Governance: Addressing Climate Change in America,* compiled by Barry Rabe, (Washington, D.C.: Brookings Institution Press, 2010), 59.
[99] Martha Derthick, "Compensatory Federalism," 62.
[100] Martha Derthick, "Compensatory Federalism."

descriptive term for governance in federal systems that goes beyond the usual two levels that define federal systems."[101] This term originated to describe governance style in the European Union, but is applicable to any multilevel system. Multilevel governance is common and critical in environmental policy. In environmental governance, cities squeeze their way into the typically two-sided discussion of federalism. Instead of sole responsibility lying with either the state, the federal government, or a combination of the two, cities are responsible for many aspects of environmental policy planning. Federal and state law supersede many decisions made at the city level, but, as with the relationship between the states and the federal government, change at the city level often causes change at the national level. Cities also often must compensate for a lack of environmental policy at the state and federal levels.

To protect their concentrated populations and wealth, cities can either enact their own SLRA policy, rely on state-level policy, or use a combination of the two. The state and the federal government, however, often lack the specific knowledge necessary to dictate detailed city plans. Both the state and federal government must consider the needs of multiple coastal areas when setting policy. The city can focus on itself, developing appropriate development restrictions, building protective barriers, or creating drainage systems. My categories of city-state relationships in SLRA look at whether cities rely on state-level policy to determine city-planning efforts, whether they enact independent policies, or whether they rely on cooperative policies at both levels.

My framework for evaluating SLRA policy making is based on evaluation of city autonomy. I decided to look at autonomy in part because Rabe's categories focus on autonomy of the state in relation to the federal government. In SLRA, I found that questions of autonomy

[101]Inger Weibust and James Meadowcroft, *Multilevel environmental governance: managing water and climate change in Europe and North America*, (Cheltenham, UK: Edward Elgar, 2014.)

applied at the city level, too. If the city is highly autonomous in its SLRA policy making, it falls into a category of "limited-constraint autonomy." If the city is autonomous in some areas of SLRA policy making but not others, it falls into a category of "conflicted autonomy." If the city and the state have policies about SLRA that work well together, I call the situation an example of "cooperative governance." This category is like Derthick's category of collaborative federalism. I call instances where the state preempts the SLRA policy making at the city level, limiting city autonomy significantly, examples of "state mediation." These four levels of city autonomy cover two distinct pieces of city-level SLRA: how a city makes decisions about SLRA and whether a city relies on federal data and mapping for city planning purposes.

Limited-Constraint Autonomy	**Conflicted Autonomy**	**State Mediation**	**Cooperative Governance**
The city sets and enacts policy decisions without significant state interference. The city chooses how to interact with federal policies.	The city sets and enacts some policy decisions while the state controls others. The city and state both make conflicting decisions about interaction with federal policies.	The state sets and enacts policy decisions without significant city interference. The state chooses how to interact with federal policies. Cities are compelled to comply.	The city and state both contribute to policy creation and implementation. One or both layers of government provides aid to the other. Both layers of government interact with the federal level.

These categories fall under the umbrella of multilevel governance because they involve three levels of government. Federal law preempts much of what cities and states do regarding SLRA because federal law describes the requirements necessary to participate in NFIP. Most coastal or riverine cities in the U.S. comply with federal NFIP standards. Cities and states are not

required to use only federal data and resources to make SLRA policy decisions, however; if SLRA policy adheres to baseline FEMA and NFIP requirements, the city or state has the option to use other resources to further SLRA. For example, Charleston complies with NFIP requirements but relies on data outside the federal government to decide city planning questions. In instances of limited-constraint autonomy or state mediation, the dominant governing body for SLRA chooses whether to rely solely on federal resources or not. In cases of collaborative governance, the state and city have coordinated policies relating to the use of federal resources. In conflicted autonomy situations, where the opposite is true, the city and state disagree on how to use federal resources or apply them unevenly.

I categorize my case studies based on how autonomous the cities are in SLRA planning. Each of my four case cities fits in a different category. Atlantic City is an example of state mediation, Charleston is an example of limited-constraint autonomy, New York City an example of collaborative governance, and Hoboken is an example of conflicted autonomy. Through analysis of these case studies, I determine which of the four categories of city autonomy is most effective for SLRA policy making based on the GCC criteria, combining this categorization framework with the evaluative one.

New Jersey

1. **Facts and Risk**

All coastal regions of the United States are at risk of increased flooding due to climate change induced SLR. New Jersey is particularly vulnerable to the impacts of SLR because it has a dense coastal population, with significant amounts of wealth concentrated in coastal cities. The

New Jersey coast is at risk of two types of flooding due to SLR, sudden onset floods from storms and slow flooding from steady sea level rise over time. In this section, I will discuss SLRA management at the state level and then look at two different cities: Atlantic City and Hoboken. SLRA efforts in New Jersey are primarily run at the state level, which is clear in Atlantic City. However, a few cities, including Hoboken, have chosen to develop their own SLRA policies separate from the state.

New Jersey is densely populated, with about 8.6 million people in 119,210 square kilometers.[102] In Atlantic City, for example, 47,401 housing units fall in the FEMA-designated Special Flood Hazard Area (SFHA). The SFHA includes 74,434 people, which is 27.13% of the total Atlantic City population.[103] According to recent U.S. Census data, permanent coastal populations in New Jersey are shrinking overall. In Atlantic City, for example, the percent change in population of the last ten years is -2.4%.[104] This is in part because of the movement away from the coast after Hurricane Sandy hit in 2012. Despite the drop in year-round residents, the number of coastal vacation properties built increased by about 6.3 percent between 2012 and 2014.[105] The number of individuals living in coastal populations over the age of 65 continues to grow, despite the drop in permanent residents overall. Between 1970 and 2010, the over 65 population in shoreline counties has increased by 178%.[106] This is important to note, as elderly

[102] Matthew J. P. Cooper, Michael D. Beevers, and Michael Oppenheimer, "The potential impacts of sea level rise on the coastal region of New Jersey, USA," *Climatic Change* 90, no. 4 (2008): 475-92.
[103] "Special Flood Hazard Area Exposure Resource Map v2.0," *FEMA ArcGIS*, map, accessed January 17, 2017.
[104] Star-Ledger Staff, "Census Results Show N.J. Shore Town Populations Are Shrinking," *NJ.com*, last modified May 12, 2011, Accessed January 4, 2017.
http://www.nj.com/news/index.ssf/2011/05/census_results_show_nj_shore_to.html
[105]Tim Evans, "Population Trends at the Jersey Shore, Part 2: The Sandy Effect," *New Jersey Future,* last modified November 1, 2016, Accessed January 4, 2017, http://www.njfuture.org/2016/11/01/pop-trends-shore-2/
[106] "National Coastal Population Report Population Trends from 1970 to 2020," *NOAA*, last modified 2013, accessed January 4, 2017,
https://www.google.com/search?q=National+Coastal+Population+Report+Population+Trends+from+1970+to+2020&ie=utf-8&oe=utf-8

populations are unlikely to have the capacity to move out of the area if it is hit again by coastal flooding.

Barrier islands line the New Jersey coast. NOAA defines barrier islands as "long, narrow, offshore deposits of sand or sediment that run parallel to the coastline. They are separated from the mainland by a shallow sound, bay, or lagoon and are often found in chains along the East Coast and Gulf of Mexico."[107] The barrier islands along the New Jersey coast are frequent tourist destinations, including Atlantic City, Seaside Heights, Seaside Park, Toms River, and Bay Head. The barrier islands are thin and low-lying, putting them at high risk of sea level rise induced flooding. The barrier islands may become totally submerged if sea levels rise continue to rise at current rates; the only way to save these islands is to build protective barriers.

The New Jersey Climate Adaptation Alliance (NJCAA), run by Rutgers University, predicts that, following national trends, sea levels could rise to a foot along the New Jersey shoreline by 2100 if emission habits remain the same.[108] Other studies, by Michael J. Cooper, Michael D. Beevers, and Michael Oppenheimer at Princeton University, analyzing tidal wave data collected by NOAA show that the average sea level increase across New Jersey is 3.55 millimeters per year. In Sandy Hook, tides are rising at 3.88 mm per year; in Atlantic City the rate is 3.98 mm per year, in Cape May it is 3.98 mm per year, in Battery Park it is 2.77 mm per year, and in Lewes it is 3.16 per year.[109] The NJCAA estimates a 50% probability of a .8 foot rise across the state by 2030 and a 1.4 foot rise by 2050. They predict a 67% chance of a .6-1-

[107] "Barrier Islands- Habitat of the Month," *NOAA*, accessed January 14, 2017. http://www.habitat.noaa.gov/abouthabitat/barrierislands.html
[108] New Jersey Climate Adaptation Alliance, *Climate Change and the Jersey Shore: Impacts on Coastal Communities, Ecosystems and Economies* (Rutgers, 2016), Accessed January 2 2017.
[109] Matthew J. P. Cooper Michael D. Beevers, and Michael Oppenheimer. "The potential impacts of sea level rise on the coastal region of New Jersey, USA."

foot rise by 2030, a 1.0-1.8 rise by 2050, and a 1.7-4.5-foot rise by 2100 depending on the emission levels over the next few decades.[110]

Any increase in sea level would increase the strength of storms hitting the New Jersey coast. Hurricanes and tropical storms cause floods, and the height and volume of the water at the time of a storm determines, in part, how far inland flood water will reach. According to the U.S. Climate Resilience Toolkit, storm tides can raise water levels up to twenty feet above sea level.[111] Since 1900, storm surge heights have risen about eight inches across the U.S. With every increase in sea level height, storm tides rise higher.[112]

Tides are higher in New Jersey now than ever before, leading to increased tidal flooding. In the 1970s, Atlantic City experienced about five days per year of tidal flooding, but now experiences about 30 days of flooding per year.[113] The Union of Concerned Scientists expects that New Jersey will experience between 80 and 130 tidal floods a year by 2030.[114] Increased tidal flooding, coupled with increased flooding from heavy storms, puts coastal New Jersey at risk of destruction. Flooding destroys infrastructure and resources, destroys wetlands crucial to biodiversity, removes wetlands that act as carbon sinks, and leads to saltwater intrusion into fresh groundwater.[115]

Hurricane Sandy, which hit the East Coast of the United States in 2012, demonstrated how unprepared New Jersey was for coastal flooding. Still, New Jersey remains mostly unprepared for storms like Sandy. At its strongest, Hurricane Sandy had winds over sixty-five

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[110] R.E. Kopp, A. Broccoli, B. Horton, D. Kreeger, R. Leichenko, J. A. Miller, J. K. Miller, P. Orton, A. Paris, D. Robinson, C. P. Weaver, M. Campo, M. Kaplan, M. Buchanan, J. Herb, L. Auermuller, and C. Andrews, *"Assessing New Jersey's Exposure to Sea -Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel,* accessed January 2, 2017.
[111] "U.S. Climate Resilience Toolkit," *Climate.gov*.
[112] "U.S. Climate Resilience Toolkit," *Climate.gov*.
[113] Erika Spanger-Siegfried, Melanie Fitzpatrick, and Kristina Dahl. "Encroaching Tides."
[114] Erika Spanger-Siegfried, Melanie Fitzpatrick, and Kristina Dahl. "Encroaching Tides."
[115] New Jersey Climate Adaptation Alliance, *Climate Change and the Jersey Shore: Impacts on Coastal Communities, Ecosystems and Economies.*

kilometers an hour that stretched 900 miles. For comparison, Hurricane Katrina, the devastating hurricane that hit the southern coast of the U.S. in 2005, had winds of the same intensity that stretched only 300 miles.[116] Hurricane Sandy killed 147 people; twelve of those deaths occurred in New Jersey.[117] No Hurricane had caused this many deaths in New Jersey since Hurricane Agnes in 1972.[118]

The highest storm surge from Sandy in New Jersey reached 8.57 feet above average tide levels.[119] Around Atlantic City and Cape May, storm surges reached heights of 5.82 and 5.16 feet.[120] The highest flood amount was 8.9 feet above ground level in Sandy Hook.[121] Flood heights around eight feet were measured in Raritan Bay and Sayreville. Flooding reached across New Jersey because as wave heights reached record highs, sea water moved into Hudson River, causing floods along the river away from the coastline. FEMA described the effect of Hurricane Sandy on the coastline this way:

> "Up and down the state's 127 miles of coastline, boardwalks were driven off their foundations and transformed into piles of rubble. Planks and pavilions were washed out to sea. Bluffs and dunes were eroded. Stairways and benches were ripped off and carried away."[122]

The damage caused by Hurricane Sandy lead the New Jersey government to enact both repair and adaptation programs. New Jersey relies on coastal areas for tourism revenue, which accounts

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[116]Brian Dunbar, "Hurricane Sandy (Atlantic Ocean)," *NASA*, last modified March 7, 2013, accessed January 4, 2017. https://www.nasa.gov/mission_pages/hurricanes/archives/2012/h2012_Sandy.html
[117]"Hurricane Sandy Fast Facts," *CNN*, last modified November 2, 2016, accessed January 4, 2017, http://www.cnn.com/2013/07/13/world/americas/hurricane-sandy-fast-facts/
[118] Eric Blake, Todd Kimberlain, Robert Berg, John Cangialosi, and John Beven II, *Tropical Cyclone Report Hurricane Sandy*, NOAA, last modified October 2012, last Accessed January 6, 2017.
[119] Eric Blake, Todd Kimberlain, Robert Berg, John Cangialosi, and John Beven II, *Tropical Cyclone Report Hurricane Sandy*.
[120] Eric Blake, Todd Kimberlain, Robert Berg, John Cangialosi, and John Beven II, *Tropical Cyclone Report Hurricane Sandy*
[121] Eric Blake, Todd Kimberlain, Robert Berg, John Cangialosi, and John Beven II, *Tropical Cyclone Report Hurricane Sandy*
[122] "Three Years after Sandy: Most of New Jersey's Boardwalks Are Rebuilt," *FEMA*, last modified October 14, 2015, accessed January 6, 2017, https://www.fema.gov/news-release/2015/10/14/three-years-after-sandy-most-new-jerseys-boardwalks-are-rebuilt

for 6.6% of the state's economy and 10% of statewide employment.[123] To maintain that coastal tourism, the New Jersey government made SLRA and home rebuilding priorities after Sandy. Much of the rebuilding cost is covered by FEMA grants. Between 2012 and February 2016, FEMA provided $1.4 billion to individual disaster survivors, $14.2 billion to state and local governments, and $822 million in Hazard Mitigation grants.[124] This aid is spread across the various states hit by the Hurricane. Over $6.8 billion of this aid went to New Jersey by October of 2015. Also by October of 2015, NFIP had paid over $3.5 billion to individual policyholders and the Hazard Mitigation Program had granted $258,456,164 million.[125]

2. State Policy

New Jersey has programs that cover SLRA across the state. Many of these plans developed in response to Hurricane Sandy. In 2013, the New Jersey government launched reNew Jersey, a campaign to rebuild and strengthen coastal infrastructure and homes after Sandy. The campaign includes four central programs: Reconstruction, Rehabilitation, Elevation, and Mitigation (RREM) Program, Low-to-Moderate Income Homeowners Rebuilding (LMI) Program, Fund for Restoration of Multifamily Housing (FRM) Program, and Sandy Tenant-Based Rental Assistance (TBRA) Program. Federal policies are used in each of these four programs. In the RREM program, applicants for aid to repair damaged residences must have registered for FEMA assistance, funding is refused for applicants in Special Flood Hazard Areas that do not participate in the NFIP, and anyone who previously received disaster aid must have

[123] "Three Years after Sandy: Most of New Jersey's Boardwalks Are Rebuilt," *FEMA*.
[124] "Sandy Recovery Office," *FEMA*, last modified April 3, 2014, Accessed January 4, 2017, https://www.fema.gov/sandy-recovery-office
[125] "Three Years after Sandy: Most of New Jersey's Boardwalks Are Rebuilt," *FEMA*.

maintained the proper flood insurance policy since.[126] The LMI incorporates federal policies in a similar way, but leaves out the requirement that the applicant live in an area participating in NFIP.[127] Neither the FRM nor the TBRA programs requires FEMA or NFIP registration as part of the application process.[128]-[129]

As dual recovery and adaptation plan, the Christie Administration launched a $100 million project in 2013 to elevate homes to protect them from future flood damage. The program is primarily funded by FEMA's Hazard Mitigation Program. Under this new plan, homeowners can apply for elevation grants through the reNew Jersey program. Previous registration with FEMA is not required to participate or apply for a grant.[130] Under the NJ Department of Environmental Protection (NJDEP), many homeowners are now required to elevate their homes if they live in high risk flood zones, as determined by FEMA. If a home is not located in a high risk zone or did not suffer substantial damage during Sandy, then it is not legally obligated to undergo elevation. The most recent FEMA maps for New Jersey counties contain suggested elevation heights, called Advisory Base Flood Elevations (ABFEs). New Jersey laws push the FEMA elevation requirement further, requiring that the lowest floor of each building lay one foot above the ABFE.[131]

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[126] "Reconstruction, Rehabilitation, Elevation and Mitigation (RREM) Program," last modified June 2016, accessed January 6, 2016. http://www.renewjerseystronger.org/wp-content/uploads/2016/06/Reconstruction-Rehabilitation-Elevation-and-Mitigation-RREM-Program-Summary-Guidelines.docx.pdf

[127] "LMI Homeowners Rebuilding Program," *ReNew Jersey*, accessed January 6, 2017, http://www.renewjerseystronger.org/homeowners/lmi-homeowners-rebuilding-program/

[128] "Fund for Restoration of Multifamily Housing*" ReNew Jersey*, accessed January 6, 2017, Accessed January 6, 2017, http://www.renewjerseystronger.org/landlords-developers/fund-for-restoration-of-multifamily-housing-frm/

[129] "Program Guidelines: Sandy Tenant-Based Rental Assistance Program, "*ReNew Jersey*, accessed January 6, 2017, http://www.renewjerseystronger.org/renters/sandy-tenant-based-rental-assistance-program/

[130] "Christie Administration Announces $100 Million Home Elevation Program to Protect Homeowners From Future Flood And Storm Damage," *State of New Jersey*, last modified July 22, 2013, accessed January 6, 2017. http://www.tomsrivertownship.com/ada-policy-statement?id=1271:christie-administration-announces-100-million-home-elevation-program-to-protect-homeowners-from-future-flood-and-storm-damage

[131] "Fact Sheet: Rebuilding After Sandy," *State of New Jersey*, last modified June 2013, accessed January 6, 2017, http://www.state.nj.us/dep/special/hurricane-sandy/docs/rebuilding-after-sandy-factsheet.pdf

Though New Jersey recognizes the dangers of flooding and requires at-risk homes to undergo elevation, the state allows substantial construction of new buildings in at-risk flood zones. Under the Coastal Zone Management Rules (N.J.A.C. 7:7),

> "In a portion of an undeveloped flood hazard area that is 100 feet or farther from a navigable waterway, development is conditionally acceptable provided the development would not prevent potential water-dependent use in any portion of the flood hazard area within 100 feet of navigable water body."[132]

There are restrictions on building in flood zones, but none of the New Jersey laws amended after Hurricane Sandy include mention of climate change, sea level rise, or climate change induced sea level rise. Neither of the laws that cover coastal development, the Coastal Zone Management Rules and the Flood Hazard Area Control Act Implementing Rules, both amended in 2016, prevent homeowners from building in areas that most scientists agree will be underwater by 2100. The Flood Hazard Area Control Act Implementing Rules, which lay out the requirements for a permit to build in a flood risk area, do use FEMA maps to determine risk zones, but building in those risk zones is not proscribed. This seems a mistake after the amount of damage that occurred during Hurricane Sandy.

Instead of using FEMA maps to fully assess a risk zone, New Jersey grants the NJDEP authority to delineate risk zones. The NJDEP has a Cooperating Technical Partnership Agreement with FEMA where New Jersey made maps will show FEMA flood hazard area suggested elevations.[133] Only if no NJDEP delineation exists does the state use FEMA maps to determine the existence of a risk zone.[134] If neither an NJDEP nor a FEMA delineation exists, the Flood Hazard Area Control Act Implementing Rules grant permit applicants discretion to approximate risk based on a series of figures and maps included in the Implementing Rules

[132] Coastal Zone Management Rules, 7 § 7-9.25 (2016).
[133] "Background on Floodplain Management and Building Codes in New Jersey, New York State, and New York City," *NJ.com*.
[134] New Jersey Flood Hazard Area Control Act Rules, 7§ 7:13 (2016).

themselves.[135] Like allowing homeowners to rebuild in areas that proved vulnerable in Sandy, allowing permit applicants to determine the existence of a flood zone seems an unnecessary risk.

New Jersey homeowners can build in flood zones if their project is legal under other housing and construction rules in the state. N.J.A.D. 7:13 covers alteration of topography, clearing and cutting of vegetation along a river, creation of impervious surfaces, storage of unsecured materials, any form of construction on a structure, and the conversion of buildings into homes.[136] Any activity not listed here is allowed in a flood hazard zone without a permit. This appears to contradict FEMA, which says, "A permit is required before construction or development begins within any Special Flood Hazard Area."[137]

In 2013, FEMA sent a letter to Marc Ferzan, Executive Director for Recovery and Rebuilding in New Jersey, and Robert Martin, commissioner for the NJDEP, saying that the rules in N.J.A.D. 7:13 contradicted FEMA policies. The NFIP does not permit wet-proofing, defined as "permanent or contingent measures applied to a structure or its contents that prevent or provide resistance to damage from flooding while allowing floodwaters to enter the structure or area."[138] Under NFIP's Wet Floodproofing Requirements from 1993, wet floodproofing is allowed in

> "newly constructed and substantially improved residential and non-residential structures… as a flood protections technique… [in]enclosed areas below that BFE that are used solely for parking, building access, or limited storage… [and] attached garages."[139]

[135] New Jersey Flood Hazard Area Control Act Rules, 7§ 7:13 (2016).
[136] New Jersey Flood Hazard Area Control Act Rules, 7§ 7:13 (2016).
[137] "Permit for Floodplain Development," *FEMA*, accessed April 6, 2017, https://www.fema.gov/permit-floodplain-development
[138] "Wet Floodproofing," *FEMA*, accessed January 6, 2017 https://www.fema.gov/wet-floodproofing
[139] "Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas," *FEMA*. last modified 1993, accessed January 6, 2017, https://www.fema.gov/media-library/assets/documents/3503

Under the N.J.A.D 7:13, wet floodproofing is allowed in all parts of a building, in direct contradiction of NFIP policy. In response to the contradiction, the letter from Timothy P. Crowley on behalf of FEMA said

"We believe the consequences of promulgating State rules that permit construction methods that are not allowed under the NFIP will create a burdensome and confusing situation that complicates compliance by property owners, builders, developers, architects and engineers, and enforcement by communities."[140] Despite this clear conflict with FEMA, New Jersey state law controls most city-level planning efforts. That New Jersey floodplain management law does not take federal safety recommendations into account is concerning. It is dangerous for a state that contradicts federal safety regulations to have control over a city's SLRA management.

3. Atlantic City

Most SLRA planning and adaptation in and around Atlantic City is controlled by the state. These adaptation efforts are based on data provided by FEMA and funded in part by FEMA. FEMA is not the only federal source with available data on SLR, however. The various NOAA maps related to sea level rise all include data for the state of New Jersey. NOAA has also released data about the New York and New Jersey harbors collected in partnership with the New York-New Jersey Harbor and Estuary Program and Great Ecology, an environmental consulting firm. NOAA has presented its data to multiple elected officials, including county planners, the Community Advisory Group for the Raritan Bay Slag Superfund Site, and EPA officials in the

[140] "FEMA Comments on Emergency Rule to Amend the Flood Hazard Area Control Act Rules," Timothy P. Crowley to Commissioner Martin and Mr. Ferzan, October 10, 2013.

region.[141] The state still primarily uses FEMA data, not NOAA data, to determine SLRA plans, however.

With FEMA aid, the NJDEP is overseeing the repair of a damaged sea wall along Sea Bright and Monmouth beach. As of 2015, FEMA had granted $31,344,834 for the project out of an estimated total cost of $34,827,584.[142] The state of New Jersey will supply the remaining 10% of the funding. This is both a repair and an adaptation project. In another adaptation effort, The Army Corp of Engineers is in the process of building sand dunes to serve as barriers to encroaching tides. In late 2016, the Army Corp of Engineers awarded a $63 million contract to Weeks Marines, Inc. build dunes along Margate Beach, Longport Beach, Atlantic City, and Ventnor.[143] In early 2017, the USACE announced the award of a $92 million contract to Weeks Marine, a New Jersey based company, to build and replenish dunes along the barrier islands.[144] The USACE aims to see the barrier island project, while will require 11 million cubic yards of sand, finished in 2018.[145] The dunes in most barrier island areas will reach up to twenty-two feet, hopefully protecting them from complete submersion.[146]

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[141] "Planning for Sea Level Rise Adaptation at the Site Scale in New Jersey," *NOAA*, last modified September 14, 2015, accessed January 23, 2017, https://coast.noaa.gov/digitalcoast/stories/slr-site-scale.html

[142] "FEMA Grant to Fund Seawall Project in Sea Bright and Monmouth Beach," *FEMA*, last modified December 21, 2015, accessed January 2, 2017, https://www.fema.gov/news-release/2015/12/21/fema-grant-fund-seawall-project-sea-bright-and-monmouth-beach.

[143] Patricia Madej, "Jersey Shore Awarded $63 Million Contract for Dune Building, Coastal Protection Projects," *PhillyVoice*, last modified November 26, 2016, accessed January 8, 2017, http://www.phillyvoice.com/jersey-shore-awarded-millions-more-coastal-protection-projects/

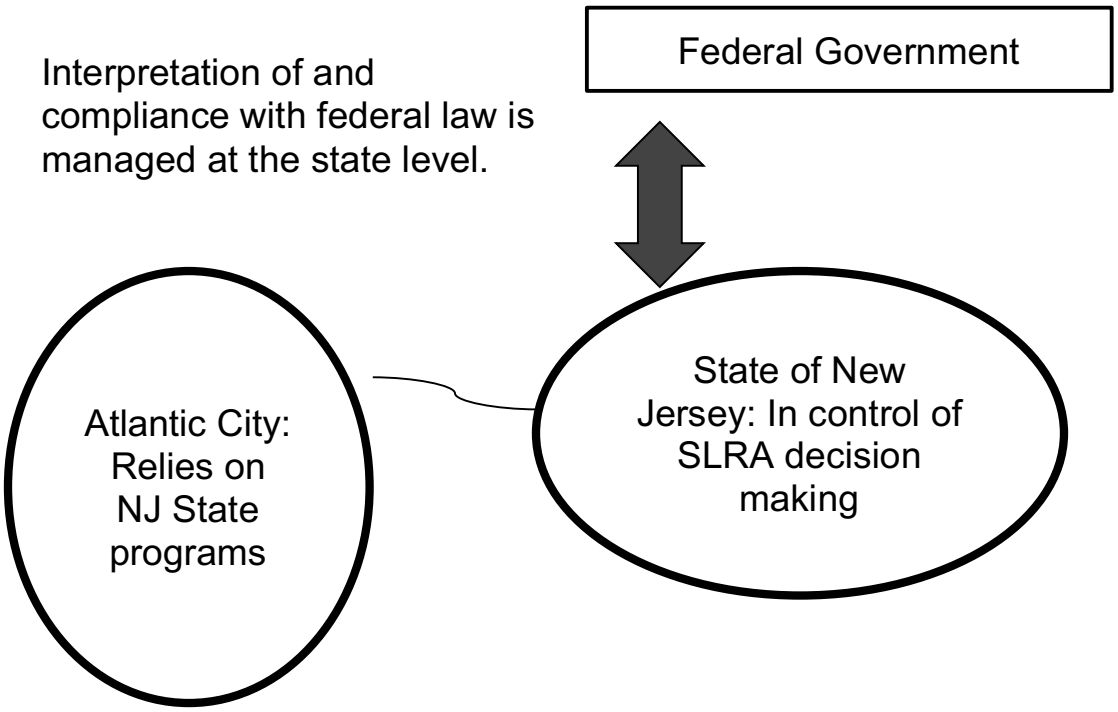
[144] Daniel Nee, "Done Deal: Contract Awarded for Barrier Island Beach Replenishment," *Brick Shorebeat*, last modified January 11, 2017, accessed January 14, 2017. http://brick.shorebeat.com/2017/01/done-deal-contract-awarded-for-island-beach-replenishment-project/

[145] Daniel Nee, "Done Deal: Contract Awarded for Barrier Island Beach Replenishment."

[146] Daniel Nee, "Done Deal: Contract Awarded for Barrier Island Beach Replenishment."

Most Recent Atlantic City FEMA map [147]

4. Categorization



[147] Atlantic City FEMA Map, *FEMA,* digital, https://msc.fema.gov/portal/search

Atlantic City is a clear example of state mediation in SLRA policy. The state controls policy making in laws about flood zone management, through the ReNew Jersey program, and through NJDEP oversight of the dune building project. Unfortunately, the state relies heavily on FEMA data to determine risk areas. While dunes may prove an effective SLRA barrier, the reliance on FEMA data for SLRA is problematic. FEMA data shows areas that might be at risk of rising tides, but does not provide information on when the sea levels will rise or on how high they will rise. By relying on this data, the state does not make fully informed adaptation decisions. This leaves Atlantic City at risk.

Atlantic City is an unusual case because the city is in such severe debt that, in November 2015, the state of New Jersey formally took over the management the city. The takeover will last for five years.[148] The city still has a functioning mayor, Don Guardian, but his power is limited. The state has the power to break union contracts, hiring and fire city workers, and to sell city assets.[149] Under this takeover, Atlantic City has limited power to enact any independent SLRA projects.

Atlantic City's state mediation SLRA efforts will likely prove less effective than efforts in cities with different governing patterns. This because NJ state law does not fully comply with FEMA standards for safety and because the state relies on data sets that do not take future risk into account. To protect a city in the long term, city planners and managers need to have a well-rounded and adaptable understanding of climate change and sea level rise. While dune building can be effective for SLRA, Atlantic City is building dunes based on static data sets. The City will remain at risk without a concrete adaptation plan based on future-looking data. As we will see

[148] Matt Arco, "N.J. takeover of Atlantic City spares town from going broke, Moody's says," *NJ.com*, last modified November 28, 2016, accessed March 9, 2016, http://www.nj.com/politics/index.ssf/2016/11/state_takeover_of_atlantic_city_credit_positive_fo.html
[149] Matt Arco, "N.J. takeover of Atlantic City spares town from going broke, Moody's says."

later, successful cities have comprehensive adaptation plans that include awareness of both the changing tides and the changing data on SLR. The state of New Jersey engages in no such consideration of future risk or future changes to SLR data.

Under state management, Atlantic City hits a few, but not all, of the criteria laid out by the GCC for effective SLRA management, making it the least successful of my four case cities. Atlantic City, unlike New York City, Hoboken, and Charleston, does not have a written adaptation plan and these GCC criteria are meant to appear in written SLRA plans. Without a comprehensive SLRA plan, Atlantic City hits only two of the six required criteria for successful SLRA. This is likely because the state of New Jersey relies on limited data sets and does not adhere to minimal FEMA safety recommendations.

	Establish Baseline SLR	**Assess Vulnerability**	**Designate Protected Areas**	**Move public Infrastructure**	**Identify land-use tools**	**Create Implementation Schedule**
Atlantic City	No. Atlantic City does not have a concrete plan that establishes a baseline	No. No baseline studies exist that all city SLRA is based on	Yes. State law requires adherence to FEMA designations for SFHAS.	No. But boardwalks are being protected by dunes	Yes Zoning, building codes, SFHA policy, dune building	Unclear

5. Hoboken

All of New Jersey's coastal cities are at risk of flooding due to sea level rise, but most lack individualized adaptation plans. The city of Hoboken, across the Hudson River from New York City, is at significant risk of flooding. In response to the risk, the city developed its own adaptation plan. According to a report by Climate Central, which combined NOAA and FEMA

data to identify risk zones, below 6 feet mean higher high water (MHHW),[150] Hoboken has 505 acres of land, 28,979 people, 68 toxic sites, 9 schools, 22 miles of road, and $2.7 billion in property value.[151] Without intervention, all of this would be destroyed by the rising tides. Hoboken already experiences Hoboken, which used to be an island, is a low-lying city with frequent floods during high tide and during heavy rainfall. Both heavy rainfall events and tidal flooding events are increasing in the Northeast U.S., and Hoboken has been unprepared up to this point, with sewer systems that are often overworked.[152]

Both Hurricane Irene in 2011 and Hurricane Sandy in 2012 caused significant damage in Hoboken. Hoboken saw a 5-foot storm surge and 10 inches of rain during Hurricane Irene and 1 inch of rain with a 13-foot storm surge in Hurricane Sandy. [153] Hurricane Sandy occurred in conjunction with a full moon, which had already brought the tide up to 20% above normal high tide, causing Sandy storm surges to reach even further inland than they would have at a normal tide. Sea level rise adds to the inland reach of floods, and if Hurricane Sandy led to a 13-foot storm surge, rising tides will likely lead to even greater surges.

Hurricane Sandy caused $100 million in private property damage and $10 million in City property damage.[154] In response to the damage, the city developed a Resiliency and readiness Plan, which lists installment of flood pumps and flood barriers, infrastructure changes, and development of a readiness team as city priorities. The resiliency plan clearly establishes a baseline SLR level for adaptive purposes: 12 to 23 inches by the end of this century.[155] The plan also lists potential funding sources, including FEMA Hazard Mitigation grants and public-private

[150] MHHW means the average height of high tides each day. 6 feet MHHW means 6 feet above that average height.
[151] "Sea Level rise and coastal flood risk: Summary for Hoboken, NJ," *Climate Central*.
[152] "Flooding Information," *Hoboken, N.J, a*ccessed January 23, 2017, http://hobokennj.gov/departments/environmental-services/storm-flood-zones/
[153] "Flooding Information," *Hoboken, N.J.*
[154] City of Hoboken, *Hoboken Resiliency and Readiness Plan.* accessed January 23, 2017, http://www.hobokennj.org/docs/publicsafety/Hoboken-Resiliency-Plan.pdf
[155] City of Hoboken, *Hoboken Resiliency and Readiness Plan.*

partnership, and the document establishes ongoing planning initiatives including the Green Infrastructure Strategic Plan and the Green Element of Master Plan to lead adaptation projects.[156] The plan cites a few challenges, including that "Unfair NFIP and Federal/ State policies do not recognize unique challenges of urban areas."[157] NFIP does not cover fully cover basements, which the Hoboken Resiliency Plan cites as a flaw because basements are an urban reality.

Along with the Resiliency and Readiness Plan, Hoboken has the 2013 Green Infrastructure Strategic Plan. The plan identifies risk levels and key risk areas, along with identifying the key infrastructure assets to protect. The plan divided the city into three zones based on the ground's ability to absorb and infiltrate water: the gray zone, the green zone, and the blue zone.[158] The gray zone contains shallow bedrock and cannot efficiently hold storm water. The green zone has soil that storm water can permeate. The blue zone has the lowest elevation levels and can hold storm water. The plan designated specific areas for certain types of storm water control mechanisms, including subsurface infiltration and storage facilities. Like the Resiliency and Readiness Plan, this document lists implementation strategies and future plans. Implementation strategies and future plans are two of the GCC criteria for successful SLR readiness.

Though Hoboken has a set of city-led plans, the state also controls some of the adaptation projects in the area. In September 2016, the NJDEP chose a resiliency project for the area, called the Hudson River Project, to protect Hoboken and nearby Jersey City and Weehawken. The project involves building a flood resistant structure that will stretch along the coastline of the

[156] City of Hoboken, *Hoboken Resiliency and Readiness Plan.*
[157] City of Hoboken, *Hoboken Resiliency and Readiness Plan.*
[158] City of Hoboken, *Hoboken Green Infrastructure Strategic Plan*, last modified October 2013, accessed March 15, 2017, http://www.hobokennj.org/docs/communitydev/Hoboken-Green-Infrastructure-Strategic-Plan.pdf

three cities. The structure will include floodwalls, seawalls, bulkheads, berms, and levees.[159] It will also include green infrastructure, including green roofs and retention basins.[160] HUD, through the post-Sandy resiliency design competition called "Rebuild by Design," granted $230 million in Community Development Block Grant (CDBG) funding to this project.[161] NJDEP had developed two other plans, but chose this option because it proved the least costly plan and the plan least likely to have an impact on local traffic.[162] Construction is set to begin in 2019.

City law follows state law in adhering to FEMA guidelines for flood zone determination, but unlike state data, Hoboken City Code includes a warning about the limitations of current sea level rise data.

> "The degree of flood protection required by this chapter is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Larger floods can and will occur on rare occasions. Flood heights may be increased by man-made or natural causes. This chapter does not imply that land outside the areas of special flood hazard or uses permitted within such areas will be free from flooding or flood damages."[163]

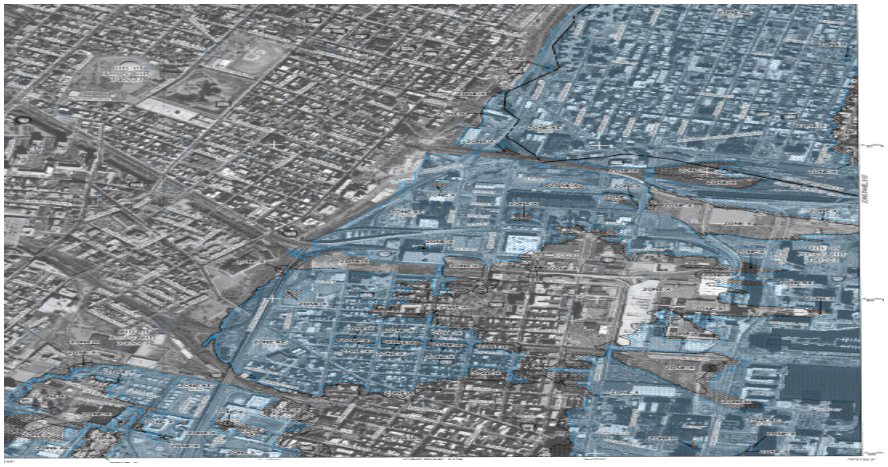
Hoboken has a comprehensive city plan to combat sea level rise while other New Jersey cities rely on the state because the city has a democratic mayor, Dawn Zimmer, who has made climate resilience a priority. Mayor Zimmer served as a member of President Obama's Task Force on Climate Preparedness and Resilience. In an NPR *Morning Edition* show, Zimmer said "We need to figure out a way to live with water."[164] She also said:

> "We have an opportunity that was impossible for other species. I'm sure that if the dinosaur could have predicted ... the ice age coming and observed it, and developed a

[159] "Flooding Information," *Hoboken, N.J.*
[160] "Flooding Information," *Hoboken, N.J.*
[161] NJDEP, "Christie Administration Moves Forward with $230 Million Project to Protect Hoboken and Parts of Weehawken and Jersey City from Storm Surge," *Nj.com*, last modified September 9, 2016, accessed January 23, 201, http://www.nj.gov/dep/newsrel/2016/16_0084.htm
[162]Steve Strunksy, "DEP picks Hoboken flood plan with least impact, protection, officials say," *NJ.com,* last modified September 20, 2016, accessed January 23, 2017, http://www.nj.com/hudson/index.ssf/2016/09/hold_dep_picks_lowest-impact_option_for_hoboken_fl.html
[163] Hoboken City Code Ch. 104 § 11 (a) (2013).
[164] NPR Staff, "For N.J. Mayor, The Time to Adapt to Rising Sea Levels Is Now," *NPR*, May 21, 2014.

plan, they would have done that. But they couldn't do that. We can do this. We can adapt. And we must adapt. We see it in Hoboken and Weehawken and Jersey City. This is the number one priority for me, as the mayor of Hoboken." [165]

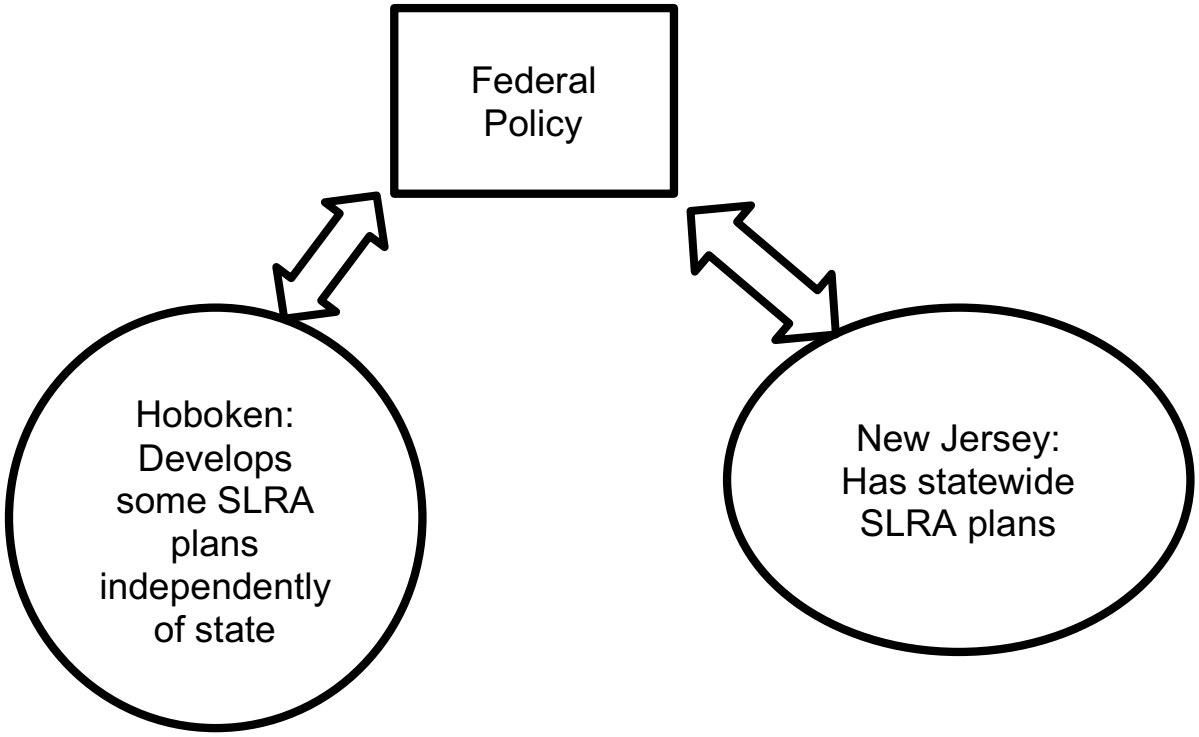
Mayor Zimmer's proactive approach to sea level rise does not directly oppose state policies, but is different from the general state attitude towards climate change. The state government recognizes climate change as an issue, but does not make adaptation a priority the way Mayor Zimmer does. The state controls some of the SLA project in the city, like the NJDEP run protective structure scheduled to begin in 2019.



Most Recent Hoboken FEMA map [166]

[165] NPR Staff, "For N.J. Mayor, The Time To Adapt To Rising Sea Levels Is Now."
[166] "Hoboken FEMA Map", *FEMA,* digital, https://msc.fema.gov/portal/search

6. Categorization



Hoboken stands out in a state where most SLRA decisions are made at the state level. Though Hoboken's plans do not break or directly contradict state law, they do stand apart from other actions across the state. Mayor Zimmer believes in the urgency of SLRA, while Governor Chris Christie has said "The climate has been changing forever and it will always change and man will always contribute to it. It's not a crisis."[167]

Hoboken is, however, making use of $11.9 million state loan to build a new flood drain.[168] Receiving state aid for flood management projects while still pushing against state norms puts Hoboken a category of conflicted autonomy, where the city relies on the state in some instances but works independently from the state in others. This is not an example of

[167] Ruby Mellen, "Chris Christie: Climate Change 'Is Not a Crisis,'"' *The Huffington Post*, last modified December 01, 2015, accessed February 28, 2017. http://www.huffingtonpost.com/entry/chris-christie-climate-change_us_565db888e4b072e9d1c3337f.
[168] *What is Flood Risk*, NJDEP, accessed March 8, 2017, http://nj.gov/dep/floodresilience/docs/rbdh-hudson-20151924-what-is-flood-risk.pdf

limited-constraint autonomy because the state is involved, but it is not an example of state mediation because many of the city plans developed independently of the state. Instead, levels of authority vary across different proposed solutions.

Hoboken's approach to SLRA will likely prove more effective in the long term than Atlantic City's approach because it hits all but one of the GCC criteria, while Atlantic City hits only a few of the criteria. Hoboken leans on state resources for funding and for management of large projects, like the Hudson River Project, but city leaders take a hands-on approach to the creation of broad adaptation policy. City leaders recognize the importance of flexibility as new data arises; this is clear in the city's warning that FEMA data has limitations. The Hoboken Resiliency and Readiness Plan is also much broader than efforts in Atlantic City's plans, including green infrastructure.

Despite conflicting levels of autonomy, Hoboken hits five out of six of the criteria from the GCC for successful SLRA management. Two of the five criteria that Hoboken hits are controlled at the city level: baseline SLR and vulnerability assessment. Protected areas are designated at the state and city level; the city designates special areas in its two adaptation plans and both the state and city require the use of FEMA designations. Land use tools are also decided at both levels. The city decided to build a flood drain, which the state is financing. The Hudson River Project is another land-use project influenced at both the state and city level. Various projects at the city and state level have implementation schedules. Though different aspects of SLRA are controlled by different levels of government, the city still engages in effective SLRA planning under the GCC guidelines.

	Establish Baseline SLR	Assess Vulnerability	Designate Protected Areas	Move public Infrastructure	Identify land-use tools	Create Implementation Schedule
Hoboken	Yes. The Resiliency Plan lists 21 to 23 inches by the end of this century as a baseline	Yes. Both the Resiliency Plan and Green Infrastructure Plan look at vulnerability	Yes. Both the Resiliency Plan and Green Infrastructure Plan list areas to protect.	No. But infrastructure will be protected by seawalls	Yes. Zoning, building codes, physical barriers and flood drains	Yes. The Hudson River Project has a set start date

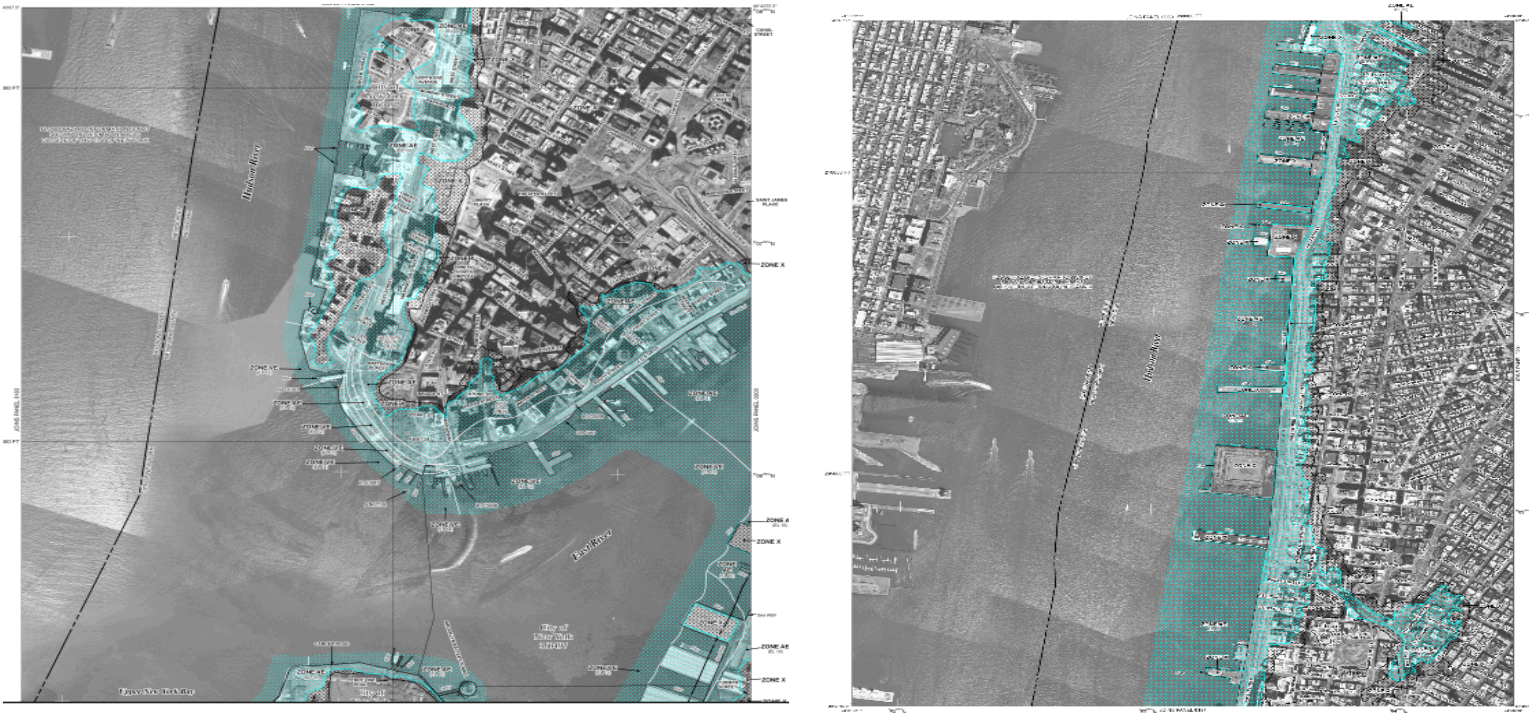
New York

1. Facts and Risk

New York State is one of the U.S. states most vulnerable to sea level rise. This is in part because of the large population concentrated in New York City and in part because of the corresponding property value and wealth concentration in the city. Most of the people in New York State live along the coast; in 2010, 62% of the New York state population lived in coastal counties.[169] Much of this coastal population is in NYC, which holds over 8.4 million people, out of the state's 19.7 million.[170]-[171] In NYC, 8.26% of the coastal area is in a special flood hazard area (SFHA) as designated by FEMA. The total number of housing units in the SFHA is 39,235. The total population in the SFHA is 81,099, which is 5.13% of the NYC population.[172]

[169] New York State Sea Level Rise Task Force, *Report to the Legislature,* December 21, 2010.
[170] "Current and Projected Populations," *NYC Planning*, accessed January 11, 201, https://www1.nyc.gov/site/planning/data-maps/nyc-population/current-future-populations.page.
[171] "Population estimates," *New York QuickFacts*, last modified July 1, 2015, accessed January 11, 2017, http://www.census.gov/quickfacts/table/PST045215/36.
[172] "Special Flood Hazard Area Exposure Resource Map v2.0," *FEMA ArcGIS.*

Significant data on SLR for New York State and New York City exists from a variety of sources. The New York State Emergency Research and Development Authority (NYSERDA) has developed its own SLR map, Coastal New York Future Floodplain Mapper, based on FEMA data from 2009 and 2014, depending on the data available for specific counties.[173] NYSERDA also has maps and data about marsh recession. Several universities in the state, including Columbia University, have their own data sets and maps as well. These maps, along with NOAA and FEMA data, provide the basis for various policy making decisions across the state.



Most Recent NYC FEMA Maps[174]

According to the New York State Sea Level Rise Task Force (SLRTF), an organization of New York-based policy experts assembled to evaluate SLR risk, sea levels have risen almost

[173] "Coastal New York Future Floodplain Mapper." *NYSERDA*, accessed February 19, 2017, http://services.nyserda.ny.gov/SLR_Viewer/About.
[174] NYC FEMA Map, *FEMA,* digital, https://msc.fema.gov/portal/search

one foot per century in New York over the last hundred years. NYSERDA, using data collected up through 2010, predicts that in New York City and Long Island will experience SLR between 2 and 10 inches in the 2020s, 7 to 12 inches in the 2050s, and 12 to 55 inches in the 2080s.[175] The lower numbers are expected if carbon emissions drop substantially, while the higher levels are expected in a rapid ice-melt scenario. Ice caps will melt more quickly if emission levels rise or do not drop significantly.

	2020s	2050s	2080s
Sea Level Rise	2-5 inches	7-12 inches	12-23 inches
Rise with Rapid Ice Melt	5-10 inches	19-29 inches	41-55 inches

Based on this data from NYSERDA, the SLRTF developed a list of risks posed by SLR in New York state: saltwater intrusion, flooding, storm surge increase, submerged infrastructure elements, and coastal erosion.[176] Sea level rise will cause significant damage at any height, though the higher estimates from NYSERDA under a rapid ice-melt scenario are particularly frightening as more New York City citizens live in 100-year floodplain zones than in any other U.S. City.[177] New York State and New York City have accepted the reality of climate change

[175] Paul Grabhorn, *Responding to Climate Change in New York State*, Edited by Cynthia Rosenzweig, William Solecki, Arthur DeGaetano, Megan O'Grady, and Susan Hassol, (Albany, NY: New York State Energy, Research, and Development Authority, 2011).
[176] New York State Sea Level Rise Task Force, *Report to the Legislature.*
[177] James Gerken, "New York City could See up to Six Feet of Sea Level Rise This Century: Report," *The Huffington Post*, published February 15, 2015, accessed April 8, 2017, http://www.huffingtonpost.com/2015/02/17/new-york-city-sea-level-rise_n_6700320.html

and sea level rise, creating task forces and government programs to begin the process of adaptation.

New York, like New Jersey, is situated in the path of hurricanes. Hurricanes, though dangerous any time they hit the land, become even more damaging with increased sea levels. As the sea levels rise, storm surge heights increase and floods reach farther inland. When Hurricane Sandy hit in 2012 with record high storm surges, Scott Kupp at Climate Central estimated that the last 20 centimeters of the high flood surge were due to SLR.[178] With a 1.2-inch increase in SLR every decade between 1900 and 2015, the water around New York state has risen over a foot.[179] When a hurricane hits, that extra water becomes part of the dangerous storm surge. Kupp estimated that the extra 20 centimeters of Hurricane Sandy flooding due to SLR led to a storm surge that impacted 11.4% more people and 11.6% more housing units than it would have without SLR.[180]

Hurricane Sandy hit New York on October 26, 2012. On that first day, the surge level in Battery Park, NY, reached 13.88 feet.[181] This surge was 3.82 feet higher than the previous recorded high in 1960. The same day, waves in New York Harbor reached 32.5 feet, surpassing a 25-foot record from Hurricane Irene in 2011.[182] New York, along with Maryland, Washington, Pennsylvania, and North Carolina, declared a state of emergency on the 26th. On the 28th, New York suspended subway, rail, and bus services. That same day, NY Governor, Andrew Cuomo, mobilized the National Guard and NYC Mayor Michael Bloomberg evacuated lower lying areas

[178]Harvey Leifart, "Sea Level Rise Added $2 Billion to Sandy's Toll in New York City," *Eos* 96 (March 16, 2015), doi:10.1029/2015eo026349.
[179] Radley Horton, Christopher Little, Vivien Gornitz, Daniel Bader, and Michael Oppenheimer, "New York City Panel on Climate Change 2015 Report Chapter 2: Sea Level Rise and Coastal Storms," *Annals Of The New York Academy Of Sciences* 1336, no. 1: 36-44 (2015), *Academic Search Complete*, EBSCO*host*.
[180] Harvey Leifart, "Sea Level Rise Added $2 Billion to Sandy's Toll in New York City,"
[181] "Hurricane Sandy Fast Facts." Cable News Network. November 2, 2016. Accessed January 4, 2017. http://www.cnn.com/2013/07/13/world/americas/hurricane-sandy-fast-facts/
[182] "Hurricane Sandy Fast Facts," *CNN*.

of the city. One month later, Cuomo estimated that Hurricane Sandy caused the state $41.9 billion in damage, with $32.8 billion of that dedicated to repair and $9.1 billion to future prevention projects.[183] New York City experienced $19 billion in damage, $8 billion of which went to various parts of NYC transport systems.[184]

2. State and City Policies

Hurricane Sandy flooded 17% of New York City, affecting 443,000 people and 88,700 buildings.[185] In response to the damage, New York City started a campaign to rebuild and restructure homes damaged by Sandy. The aptly named rebuilding program, Build It Back, provides grants and construction services to eligible applicants to rebuild homes demolished or significantly damaged and repair homes with mild to moderate damage.[186] Both repair and rebuilding require elevation of the home in compliance with FEMA advisory base flood elevations (ABFEs).[187] Elevation is required for all homes significantly damaged within the FEMA flood risk zones. All elevated homes under the Build it Back program will be elevated two feet higher than the FEMA ABFE in compliance with NYC building code.

By the end of this century, sea levels around New York may rise about six feet, which will increase the severity and reach of storms like Hurricane Sandy. The Build It Back program, though it elevates homes and floodproofs them in other ways, puts homes right back in flood zones where they may again be hit by storm surge flooding. To protect homes despite building them back in the path of storm surge flooding, the state requires that all flood zone construction

[183] "Hurricane Sandy Fast Facts," *CNN*.
[184] "A tale of Two Cities: Miami, New York & Life on the Edge," *Climate Central*, last modified August 22, 2014, accessed January 10, 2017, http://www.climatecentral.org/news/sea-level-rise-miami-new-york-17925
[185] "A tale of Two Cities: Miami, New York & Life on the Edge," *Climate Central*.
[186] "Rebuild Program," *NYC Build it Back*, accessed January 10, 2017, http://www.nyc.gov/html/recovery/html/homeowners/rebuild.shtml
[187] "Repair with Elevation Program," *NYC Build it Back, a*ccessed January 10, 2017, http://www.nyc.gov/html/recovery/html/homeowners/repair-with-elevation.shtml

go beyond FEMA ABFEs.[188] Even in areas without FEMA designations, but where flood zones are determined by the state, home builders must take flood heights into account.

> ""Base flood elevation data must be developed by the applicant for subdivision proposals and other proposed developments, including proposals for manufactured home parks and subdivisions, greater than either 50 lots or 5 acres, unless such data has been provided by the Federal insurance administrator or is available to the department from some other source. The base flood elevation data so developed must be used to assure that all new construction or substantial improvement of… residential structure… or nonresidential structures."[189]

New York requires that when a FEMA flood map and corresponding data are available for state use, the state must use the data. In Title VI of the New York State Codes, Rules and Regulations, the state declared: "The state deems it advisable to participate in a federal program of flood control in the state of New York in the manner hereinafter described."[190] State law requires that the NY Department of Environmental Conservation (DEC) use FEMA maps when designating flood zones for regulatory purposes. The Codes, Rules and Regulations of the state also require that the DEC notify the public of any changes to flood maps.

> "At least 10 but no more than 30 days prior to the effective date of a new or revised flood insurance rate map or flood boundary and floodway map published by the Federal insurance administrator, the commissioner will cause to be published in a newspaper having general circulation in the community, a notice containing the following:
>
> (1) a general description of the floodway and floodway encroachment lines applicable within the community:
> (2) locations where the community's flood insurance rate map or flood boundary and floodway map may be inspected by interested persons; and
> (3) effective date of the flood insurance rate map or flood boundary and floodway map and of the regulations applicable for floodways."[191]

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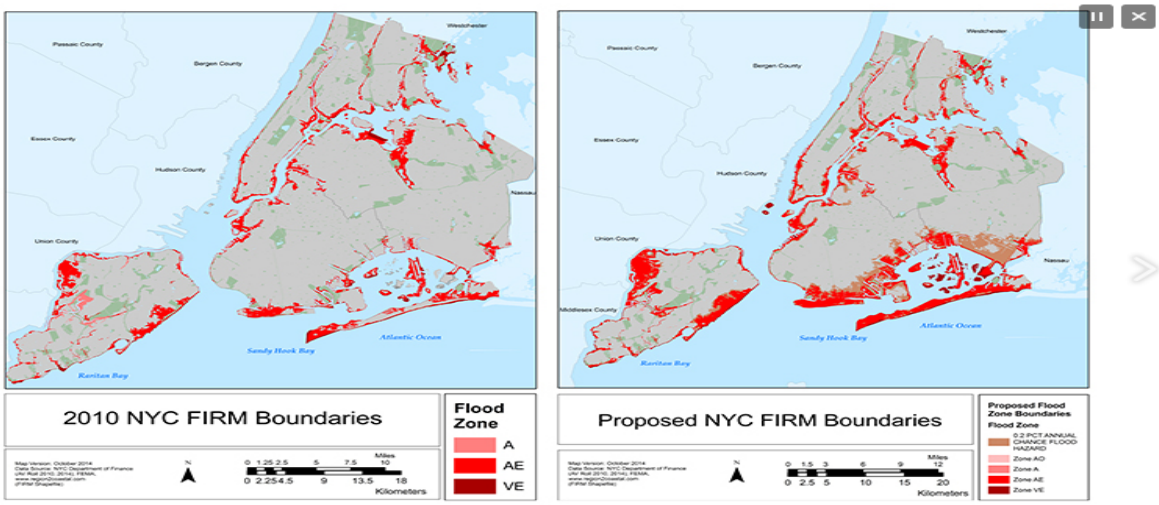
[188] NYC Emergency Management, *NYC's Risk Landscape: A Guide to Hazard Mitigation,* last modified November 2014. Accessed February 28, 2017. https://www1.nyc.gov/assets/em/downloads/pdf/hazard_mitigation/nycs_risk_landscape_a_guide_to_hazard_mitigation_final.pdf

[189] Title VI New York State Codes, Rules and Regulations Ch. V § 500.11(b)(9) (2016).

[190] NY Env Cons L § 16-0101 (2015)

[191] Title VI New York State Codes, Rules and Regulations Ch. V § 500.4 9 (b)(1)-(b)(3) (2016).

In January 2015, FEMA published new maps for several NY counties. NYC appealed the maps in June 2015, claiming that the FEMA maps overestimated flood reach by between 1-2.5 inches.[192] The original maps would have tripled the number of NYC properties in flood zones, bringing the total of NYC buildings in flood zones to 84,596.[193] Those structures would have included 400,000 people and $129 billion worth of property value.[194] An increase in property value within the flood zones would have led to a rise in insurance premiums. In response to the jump from 23,885 buildings being listed in flood zones in 2010 to the nearly 85,000 buildings listed in 2014, the state appealed to FEMA.[195] FEMA agreed to redo the maps, but the new ones have yet to be published. [196]



FEMA maps with 2010 updates compared to proposed 2016 FEMA maps.

Item 1 of 5

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[192] "About FEMA Flood Maps," *NYC Flood Maps,* 2016, accessed January 12, 2017.

[193] Emily Manley, "Number of NYC Buildings at Risk from Flooding Has Tripled," *New York Environment Report*, November 7, 2014, accessed January 12, 2017. http://www.nyenvironmentreport.com/number-of-nyc-buildings-at-risk-from-flooding-has-tripled; Bureau of Policy and Research Office of the NY State Comptroller,"*ON THE FRONTLINES: $129 BILLION IN PROPERTY AT RISK FROM FLOOD WATERS",* last modified October 2014, accessed January 12, 2017, https://comptroller.nyc.gov/reports/on-the-frontlines-129-billion-in-property-at-risk-from-flood-waters/

[194] Emily Manley, "Number of NYC Buildings at Risk from Flooding Has Tripled."

[195] Bureau of Policy and Research Office of the NY State Comptroller,*ON THE FRONTLINES: $129 BILLION IN PROPERTY AT RISK FROM FLOOD WATERS*

[196] Emily Manley, "Number of NYC Buildings at Risk from Flooding Has Tripled."

[197] Emily Manley, "Number of NYC Buildings at Risk from Flooding Has Tripled," Image.

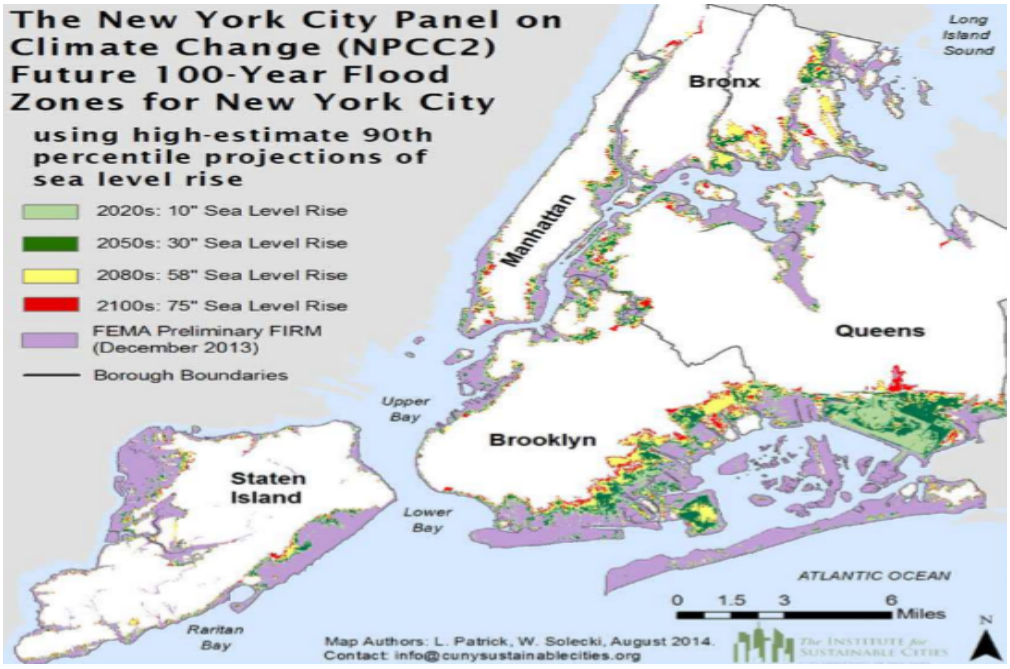
NYC relies on FEMA mapping data for flood insurance and for determining risk levels when rebuilding homes destroyed in Hurricane Sandy, but the city recognizes that "The FEMA flood maps only reflect current flood risk… It is likely that [NYC] floodplains will extend even further in the future."[198] For this reason, NYC also relies on other data sources for SLRA planning. One available data source is a set of NOAA-made maps that integrate FEMA's SFHA data with scenarios created by the New York Panel on Climate Change (NPCC), a group of made up of city and state officials, as well as scientists and city planners. In a 2013 report, the NPCC predicted a 2-11 inch SLR in NYC by the 2020s and a 7-31-inch rise by the 2050s.[199] This NPCC data came, in part, from Columbia University's Center for Climate Systems Research, CUNY's Institute for Sustainable Cities, and from Princeton University researchers.[200]

State agencies also predict risk, giving NYC yet another data point to reference when making SLRA decisions. NYC is well prepared for SLRA in this way; the city has access to a wide set of data, allowing for a broad understanding of both future and current risk. In a May 2008 report from the NYC Department of Environmental Protection (DEP), the DEP used data from the Columbia University Center for Climate Systems Research and the NASA Goddard Institute for Space Studies to determine risk levels for listed increased street and basement flooding, increased flow of seawater into sewers, and rise in groundwater levels.[201] The report suggested elevation of key infrastructure, submersible pumps, backup equipment, protective barriers, surge barriers, and retreat from at-risk areas as potential solutions.[202] This plan even suggests that NYC and NY State continue to update their SLR data sets, saying that they plan to

"Work with regulatory and other agencies on the PlaNYC initiative

[198] YC Emergency Management, *NYC's Risk Landscape: A Guide to Hazard Mitigation.*
[199] Plan NYC, *Climate Risk Information 2013,* published June 2013, accessed January 22, 2017. http://www.nyc.gov/html/planyc2030/downloads/pdf/npcc_climate_risk_information_2013_report.pdf.
[200] Plan NYC, *Climate Risk Information 2013.*
[201] NYC Department of Environmental Protection, A*ssessment and Action Plan* (NYC, 2008).
[202] NYC Department of Environmental Protection, A*ssessment and Action Plan.*

to update the existing 100-year flood elevations using current sea level data and develop agreed-upon estimates of future 100-year flood elevations, sea level rise, storm intensity, and maximum probable flood using climate change projections."[203]



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Despite relying on other sources for SLRA data, NYC does use FEMA funding for some resiliency projects, including the Red Hook Integrated Flood Protection Feasibility Study. The study focuses on establishing the Integrated Flood Protection System (IFPS) in Red Hook, a neighborhood in Brooklyn.[205] The FEMA funding is directed towards studying risk levels and potential solutions in the area. The study, funded through the Hazard Mitigation Grant Program (HMGP) began in October 2015. So far, the city has committed $50 million to the project, in

[203] NYC Department of Environmental Protection, A*ssessment and Action Plan.*
[204] "The NPCC Future 100-Year Flood Zones for New York City," NPCC. 2013, http://www.nyc.gov/html/planyc2030/downloads/pdf/npcc_climate_risk_information_2013_report.pdf.
[205] NYC Mayor's Office of Resiliency and Recovery, *Red Hook Integration Flood Protection System,* October 13, 2016, accessed January 23, 2017, https://www.nycedc.com/project/red-hook-integrated-flood-protection-system

addition to the $50 million from the HMGP.[206] Using FEMA flood map data and NPCC predictions, city planners have evaluated flood risk in Red Hook and developed potential structural solutions.[207]

After Hurricane Sandy, President Obama's Hurricane Sandy Rebuilding Task Force began a design competition to push architectural firms and construction companies to develop resilient infrastructure plans. The competition, the Rebuild by Design competition, is funded through HUD, the Municipal Art Society, Regional Plan Association, NYU's Institute for Public Knowledge, The Van Alen Institute, the Rockefeller Foundation, and other philanthropic organizations and institutes.[208] In 2014, modelling the Rebuild by Design competition, President Obama began the National Disaster Resilience Competition (NDRC).[209] The competition aimed to fund resiliency projects in states and communities impacted by major disasters between 2011 and 2013.[210]The NDRC offered $1 billion dollars to thirteen states and cities.[211] In 2016, New York City won a grant from the U.S. Department of Housing and Urban Development (HUD) for $176,000,000 through the NDRC.[212] New York State won $35,800,000 for resiliency projects, in addition to the money granted to New York City.[213]

One of the projects awarded money through the NDRC competition and the Rebuild by Design competition is the Big U, or the Dryline. The Dryline would be a ten-mile protective

[206] NYC Mayor's Office of Resiliency and Recovery, *Red Hook Integration Flood Protection System.*
[207] NYC Mayor's Office of Resiliency and Recovery, *Red Hook Integration Flood Protection System.*
[208] "Origin and Impact," *Rebuild by Design*, accessed January 13, 2017. http://www.rebuildbydesign.org/our-work/sandy-projects
[209] "Origin and Impact," *Rebuild by Design*.
[210] "HUD Awards $1 Billion Through National Disaster Resilience Competition." *Rockefeller Foundation.*
[211] "Origin and Impact," *Rebuild by Design*.
[212] "HUD Awards $1 Billion Through National Disaster Resilience Competition." *Rockefeller Foundation,* January 21*,* 2016*, a*ccessed January 13, 2017. https://www.rockefellerfoundation.org/about-us/news-media/hud-awards-1-billion-through-national-disaster-resilience-competition/
[213] "HUD Awards $1 Billion Through National Disaster Resilience Competition." *Rockefeller Foundation.*

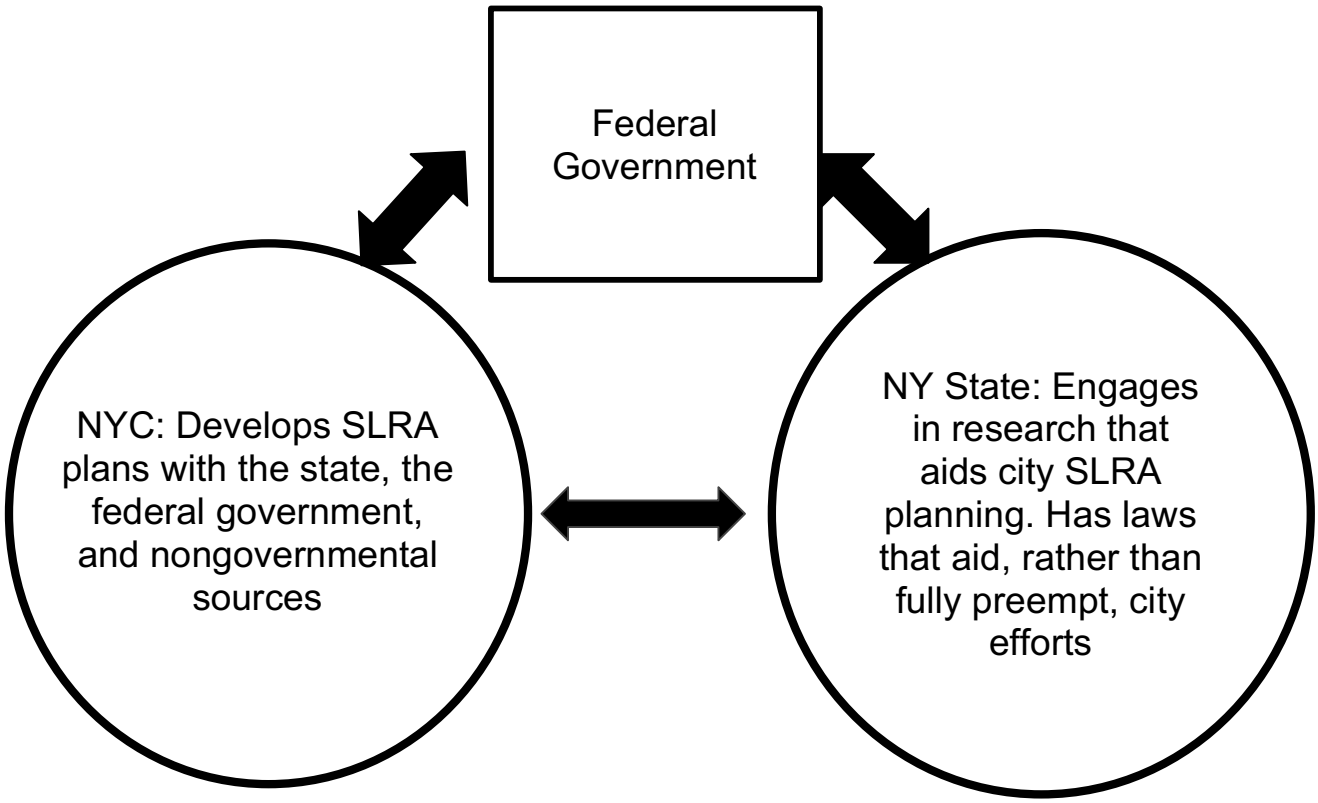
barrier around NYC.[214] This project is part of a wider initiative, called One NYC, intended to improve several aspects of city infrastructure, including general climate resiliency. HUD granted the project $511 million in total, including the funds HUD contributed to the Rebuild by Design and NDRC competitions.[215] Since the idea first won funding through the NDRC competition, NYC has pledged another $305 million in funding.[216] Several groups worked to create the Dryline: the Bjarke Ingels Group (BIG), One Architecture, Starr Whitehouse, James Lima Planning and Development, Green Shield Ecology, AEA Consulting, Level Agency for Infrastructure, ARCADIS, and Buro Happold.[217] The Dryline project is broken into a few sections: the Lower Manhattan Coastal Resiliency Project (LMCR) and the East Side Coastal Resiliency Project (ESCR). The NYC Department of Design and Construction (DDC) and Department of Parks and Recreation (DPR) will oversee the project.[218]

In addition to this large project carried out by the city, the state, and various nongovernmental groups, city SLRA efforts include storm water management, green infrastructure, dry and wet floodproofing, elevating streets, and protecting critical infrastructure with bulkheads, surge barriers, levees, and floodwalls.[219] About 25% of NYC shoreline is already protected by bulkheads. NYC plans to continue building resilience capacity through projects like Build it Back and the Dryline, increasing the capacity of city infrastructure to handle SLR. The comprehensive waterfront management plan for 2020, called "Vision 2020," includes a list of possible actions to take to build resilience throughout the city, including "potential requirements for more stringent flood protection of buildings in flood-vulnerable

[214] "The Big U," *Rebuild by Design, a*ccessed January 13, 2017, http://www.rebuildbydesign.org/our-work/all-proposals/winning-projects/big-u
[215] "The Big U," *Rebuild by Design.*
[216] "The Big U," *Rebuild by Design.*
[217] "The Big U," *Rebuild by Design.*
[218] "Frequently Asked Questions," *NYC: East Side Coastal Resiliency Project, a*ccessed January 13, 2017, http://www1.nyc.gov/site/escr/resources/frequently-asked-questions.page
[219] NYC Emergency Management, *NYC's Risk Landscape: A Guide to Hazard Mitigation.*

areas; updating FEMA flood maps to accurately reflect current topography; the periodic updating of emergency-response plans; improvements to the coastal permitting processes necessary to undertake adaptation; and public education about climate-related risks and opportunities to address them."[220]

3. Categorization:



New York City is a cultural and financial capital of both the U.S. and the world. With millions of inhabitants, hundreds of thousands of visitors, and billions of dollars in property value, NYC requires significant fortification against rising tides. New York State and NYC both engage in SLRA policy making; the two levels of government do not come into conflict over SLRA like they do in the Atlantic City case, however. State and city leaders agree on the

[220] NYC Department of City Planning, *Vision 2020: NYC Comprehensive Waterfront Plan,* published March 14, 2011, accessed January 13, 2017, http://www1.nyc.gov/site/planning/plans/vision-2020-cwp/vision-2020-cwp.page

importance of climate resilience and work together to research risk and develop solutions. For example, the city relies in part on NYSERDA data and on New York State Sea Level Rise Task Force (SLRTF) data for local decision making. NPCCC data on climate risk was adopted by the State, demonstrating that research flows both from the city to the state and vice versa.[221]

I predict that the NYC adaptation policies will prove effective over the next several decades. The city has seen effective SLRA planning through projects like Build It Back and the Dryline that involve cooperation between multiple levels of government and between nongovernmental organizations. Though the Dryline is still in its planning stages, the project demonstrates NYC's ability to cooperate with multiple sources. The city uses federal, state, and nongovernmental resources to develop multifaceted plans that include green infrastructure and multiple types of physical barriers. The Dryline alone involved state resources, city resources, federal resources, and aid from nongovernmental organizations. The ability to work with multiple organizations and levels of government at once will prove important for future development of SLRA strategy. SLR data continues to change as climate change worsens and the capacity to adapt strategies to changing data is crucial. NYC has an exceptional capacity to adapt to changing data because of the number of resource pools it pulls from.

NYC fills five of the six criteria from the GCC for successful SLRA management. The filled criteria come from city-level management or cooperative efforts, like NPCC and NYSERDA data collection on baseline SLR and vulnerable areas. NYC does not fulfill the requirement to move public infrastructure, but NYC does have a plan to protect its major roads and critical buildings through the Dryline project. Though protecting infrastructure is important in SLRA, this does not count as a fulfilment of the GCC criteria. NYC is proof that large cities can successfully engage in SLRA management through a cooperative governance system.

[221] NYC Department of City Planning, *Vision 2020: NYC Comprehensive Waterfront Plan.*

	Establish Baseline SLR	Assess Vulnerability	Designate Protected Areas	Move public Infrastructure	Identify land-use tools	Create Implementation Schedule
NYC	Yes. NYC bases its decisions off NPCC data, which establishes a baseline level of SLR	Yes. NPCC data assess vulnerability	Yes. NPCC data designates risk areas. FEMA data designates SFHAS	No, but infrastructure will be protected by seawalls and other adaptive barriers	Yes. Zoning, building codes, physical barriers	Yes. The Dryline has an implementation schedule

South Carolina

1. **Facts and Risk**

South Carolina is another state that is particularly vulnerable to climate change induced sea level rise. According to Climate Central, more than 800 square miles of land in the state are less than 4 feet above the high tide line, which is the area that a high tide typically reaches.[222] This area just above the high tide line includes about $24 billion worth of property value and 54,000 homes. Most of those homes just 4 feet above the high tide line are in Charleston and Beaufort Counties. South Carolina also has 1,200 miles of road in this area, 13 schools, 33 religious buildings, and 76 hazardous waste sites.[223] Climate Central, using tidal gauge data and NOAA scenarios of sea level rise rates, predicts an average rise of 1.2 feet by 2050 and an average rise of 4 feet by 2010.[224] In the slowest ice melt and sea level rise scenario, sea levels

[222] B. C. Strauss, Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz, *South Carolina and the Surging Sea,* (Climate Central July 2014), Accessed January 15, 2017, http://sealevel.climatecentral.org/uploads/ssrf/SC-Report.pdf
[223] B. C. Strauss, Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz, *South Carolina and the Surging Sea.*
[224] B. C. Strauss, Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz, *South Carolina and the Surging Sea.*

could rise .6 feet by 2050 and 1.8 feet by 2100.[225] In the fastest scenario, sea levels could rise up to 1.8 feet in 2050 and 6.5 feet in 2100.[226] Flooding is already common in South Carolina, but Climate Central predicts that by the end of the century, floods will reach 8 or 9 feet above the high water line.[227]

In their report on rising tides, called "Encroaching Tides," the Union for Concerned Scientists writes:

> "In… Charleston, where residents are already familiar with frequent coastal flooding and the occasional extensive flood during heavy rains and storms, less than half a foot of sea level rise will mean that high tides alone could flood substantial areas up to two dozen times per year, on average, by about 2030."[228]

Charleston already faces about 24 tidal flooding events each year. As sea levels rise, those tidal floods reach farther onto land. Sea levels around Charleston have already risen over 5 inches in the last 40 years and the number of tidal floods have doubled every twenty years.[229]

Much of South Carolina is low-lying; this area is aptly called the Lowcountry. Tidal floods already reach cities along the Lowcountry. Further reaching tides caused by increased sea levels will lead to beach erosion, saltwater intrusion, and destruction of property. Charleston already experiences flooding from sea level rise and from rainfall. Charleston is experiencing fewer rainstorms than in previous decades, but the rain storms are more intense.[230] The intense rainstorms, called "rain bombs," are too heavy for the city's drainage systems to handle. In an interview with Climate Central, the Charleston Public Service Director, Laura Cabiness, said

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[225] B. C. Strauss, Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz, *South Carolina and the Surging Sea*.
[226] B. C. Strauss, Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz, *South Carolina and the Surging Sea*.
[227] B. C. Strauss, Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz, *South Carolina and the Surging Sea*.
[228] Erika Spanger-Siegfried, Melanie Fitzpatrick, and Kristina Dahl, "Encroaching Tides."
[229] Erika Spanger-Siegfried, Melanie Fitzpatrick, and Kristina Dahl, "Encroaching Tides."
[230] Bobby Magill, "The front Lines of Climate Change: Charleston's Struggle," *Climate Central*, last modified January 9, 2014, accessed January 16, 2017, http://www.climatecentral.org/news/the-front-lines-of-climate-change-charlestons-struggle-16934

"[The drainage system] will handle a 10-year storm event- 6.8 inches of rain in a 24-hour period."[231]

Along with heavier rainfalls, Charleston experiences land subsidence and erosion. FEMA data, as I discussed in the second section of this paper, does not take erosion into account. The erosion around Charleston causes marshes to move inland or to disappear completely.[232] In 1986, the EPA predicted that sea level rise could lead to a loss of between 50% and 90% of the marsh around Charleston.[233] The EPA found that rapid sea level rise in the future could put marshes underwater, if they did not shift inward. Marshes could move inward if the rate of beach erosion does not overpower the rate at which the waves push sand further onto the land.

On top of erosion and heavy rainfall, Charleston lies in the path of hurricanes. Hurricane Matthew hit South Carolina in the fall of 2016, killing three people, cutting power, and washing Civil War cannonballs onto the shore.[234] In Charleston, Hurricane Matthew led to the closing of about one hundred streets.[235] Hurricane Matthew created a nine-foot storm surge in Charleston Harbor.[236] This was the third largest storm surge ever recorded in Charleston, after Hurricane Hugo in 1989 and a large storm in 1940. Storm surges will increase with sea level rise, as the rising tides cause the flood from storms to move further inward. According to Climate Central predictions, if sea levels rise to the higher end of the predicted range, floods greater than those

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[231] Bobby Magill, "The front Lines of Climate Change: Charleston's Struggle."
[232]John Tibbets, "Rising Tide: Will Climate Change Drown Coastal Wetlands?" *Coastal Heritage* 21, no. 3 (2007), accessed January 17, 2017, http://www.scseagrant.org/Content/?cid=149.
[233] Timothy Kana, Bart Baca, and Mark Williams, "Potential Impacts of Sea Level Rise on Wetlands around Charleston, South Carolina," *Environmental Protection Agency, Office of Policy Planning and Evaluation* (May 1986), accessed January 17, 2017, DOI: 10.1007/s10584-008-9422-0
[234]Pam Wright, "Hurricane Matthew Leaves Three Dead in South Carolina, Washes Up Civil War-Era Cannonballs; Thousands Remain Without Power," *Weather.com*, last modified October 9, 2016, accessed February 22, 2017, https://weather.com/news/news/hurricane-matthew-south-carolina-update
[235] Pam Wright, "Hurricane Matthew Leaves Three Dead in South Carolina, Washes Up Civil War-Era Cannonballs; Thousands Remain Without Power,"
[236] "Matthew gives S.C. coast a historic pounding," *Charlotte Observer*, last modified October 8, 2016., accessed February 22, 2017, http://www.charlotteobserver.com/news/local/article107000697.html

caused by Hurricane Hugo, the most damaging hurricane in Charleston to date, would become yearly events starting in 2090.[237]

2. State Policy

The South Carolina Emergency Management Division (SCEMD) website suggests that homeowners and contractors avoid building in flood prone areas unless the new homes are elevated and properly reinforced.[238] South Carolina law, unlike New York State and New Jersey law, does not include any clear rule about whether the state must rely on FEMA maps to determine flood zones. South Carolina law does, however, require that construction in "critical areas" fit certain criteria. "Critical areas" include coastal waters, tidelands, beaches, and dunes.[239] South Carolina grants itself control over critical areas in Title 48 of the South Carolina Code of Laws:

> "A variety of federal agencies presently operate land use controls and permit systems in the coastal zone. South Carolina can only regain control of the regulation of its critical areas by developing its own management program. The key to accomplishing this is to encourage the state and local governments to exercise their full authority over the lands and waters in the coastal zone."[240]

The Department of Health and Environmental Control - Coastal Division (DHEC-CD), determined critical areas for the state on its own using field surveys and aerial photography. Under Chapter 30 of the South Carolina Code of Regulations, the DHEC-CD has authority to grant or deny permits to individuals seeking to build in these critical areas. Before granting a permit, the DHEC-CD must consider any impact on the flow of navigable waters, the impact on marine life and wildlife, the impact on natural resources, the amount of erosion the structure

[237] B. C. Strauss, Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz, *South Carolina and the Surging Sea*.
[238] "Floods," *South Carolina Emergency Management Division*, last modified 2010, accessed January 16, 2017,http://www.scemd.org/planandprepare/disasters/faqs
[239] Title 48 South Carolina Code of Laws Ch. 39 § 48-39-10 (J) (1)- (J) (4) (2011).
[240] Title 48 South Carolina Code of Laws Ch. 39 § 48-39-20 (1993).

might cause, and the long term effects of building in the area in general.[241] The DHEC-CD "shall discourage new construction the beach/dune system and encourage those who have erected structures within the system to retreat."[242] The only mention of FEMA in Chapter 30 of the South Carolina Code of Regulations is under discussion of federal purchase of damaged property. Under the NFIP, FEMA may buy damaged property from its owners in high risk areas. Chapter 30 reiterates this federal provision.[243] This chapter does not mention FEMA flood maps.

Overall, South Carolina law includes limited discussion of flood management and coastal development. This is unlikely to change in the next few years, as the current governor, Henry McMaster, does not take a strong stance on climate change.[244] The state does not take a strong stance on climate change or sea level rise, so the responsibility of adaptation falls to the cities. The cities, fortunately, are prepared and capable.

Most recent Charleston FEMA map[245]

[241] South Carolina Code of Regulations ch. 30 § 30-11 (A)- (C) (1978).
[242] South Carolina Code of Regulations ch. 30 § 30-11 (D) (1) (1978).
[243] South Carolina Code of Regulations ch. 30 § 30-21 (D) (5) (d) (1978).
[244] "Lieutenant Governor Questionnaires," Conservation Voters of South Carolina, last modified 2016., accessed March 21, 2017. http://cvsc.org/from-the-campaign-trail/lieutenant-governor-questionnaires/
[245] Charleston County Map,*FEMA,* digital, https://msc.fema.gov/portal/search

3. City Policy

The city of Charleston has more specific flood-related laws than the state laws does. Chapter 27 of the South Carolina Code of Ordinances holds that FEMA maps will designate the special flood hazard areas for the city.

> "The areas of special flood hazard identified by the Federal Emergency Management Agency in the latest edition of its flood insurance study and so designated on its latest editions of its flood insurance rate maps (FIRM) for the city and county, and other supporting data, and any revision thereto are adopted by reference and declared to be a part of this division."[246]

Charleston law requires that all new construction and improvement projects must elevate the lowest floor of a structure to one foot above the ABFE listed on the FEMA flood map.[247]

Charleston county is under FEMA mapping revision at present. Preliminary maps were released in September.[248] Charleston brings building code into compliance with FEMA flood maps immediately upon the release of a new FEMA map. Based on preliminary maps, Charleston city planners start urging developers to bring buildings into compliance with the new suggested code.[249] Developers are required to comply with the map in use at the time that their building permit was issued. If, however, the developer does not begin construction between the time of the permit grant and the time a new map is released, the developer must comply with the new map.[250]

Charleston is at significant risk of sea level rise induced flooding. In Charleston, 75,439 housing units exist in the special flood hazard area (SFHA). 142,937 people live in the SFHA, which is 40.98% of the city's total population.[251] Charleston went from experiencing an average

[246] Charleston, SC. Code of Ordinances Ch. 27 art. II § 27-105 (2008).
[247] Charleston, SC. Code of Ordinances Ch. 27 art. II § 27-120 (2014).
[248] "Interview with Van Hewett, Charleston Plan Reviewer," Telephone interview by Emma Eisendrath, January 26, 2017.
[249] Interview with Van Hewett, Charleston Plan Reviewer," Telephone interview by Emma Eisendrath.
[250] Interview with Van Hewett, Charleston Plan Reviewer," Telephone interview by Emma Eisendrath.
[251] "Special Flood Hazard Area Exposure Resource Map v2.0." Map. FEMA ArcGIS. Accessed January 17, 2017.

of two days of tidal flooding a year in the 1970s to having about 24 tidal flooding events a year.[252] The city could experience an average of 180 days of tidal flooding in the year 2045.[253] In response to these risks, city officials have been developing SLRA projects for several years.

In 2015, Charleston published a "Sea Level Rise Strategic Plan." The plan is based on data that says sea levels will rise 1.5 to 2.5 feet in the next fifty years. It looks at past flooding, assesses vulnerability, and identifies areas where flood prevention infrastructure is needed. [254] Though the plan uses a 1.5-2.5-foot rise over the next 50 years as a benchmark for decision making, the plan suggests that critical infrastructure, like police stations and hospitals, be constructed under the assumption that sea levels will rise more than 2.5 feet. The strategy has three parts: reinvesting, responding, and readiness. The reinvesting plan involves updating and strengthening existing structures and programs, including a drainage plan adopted in 1984. Since 1984, Charleston has set aside about $235 million for drain updating projects. The drainage plan should be finished by 2020 and cost approximately $154 million.[255] To strengthen infrastructure, roads will be raised if planners deem it necessary in the future. Under the response portion of the strategy, Charleston plans to invest in better response tools for disasters. The readiness part of the plan involves working with local and national agencies to combine and compare resiliency strategies.[256] Charleston also uses FEMA Geographic Information Systems (GIS) to determine potential losses from floods and other disasters.[257] These actions fall under the guidelines recommended by the Georgetown Climate Center.

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[252] Erika Spanger-Siegfried, Melanie Fitzpatrick, and Kristina Dahl, "Encroaching Tides;" City of Charleston, *Sea Level Rise Strategy,* published December 2015, accessed January 16, 2017. http://www.charleston-sc.gov/DocumentCenter/View/10089
[253] City of Charleston, *Sea Level Rise Strategy.*
[254] City of Charleston, *Sea Level Rise Strategy.*
[255] City of Charleston, *Sea Level Rise Strategy.*
[256] City of Charleston, *Sea Level Rise Strategy.*
[257] City of Charleston, *Sea Level Rise Strategy.*

According to Carolee Williams, the Project Manager for Charleston's Department of Planning, Preservation and Sustainability, FEMA maps were not used to create the 2015 strategic plan.[258] FEMA maps for Charleston County date back to 2004 and are not all available in digital formats. Williams believes that "FEMA is not empowered to look at the future." The Union for Concerned Scientists and the GAO also cite this concern.[259]Instead of using data that does not take future risk into account, the creators of the Charleston plans used NOAA data. Unlike FEMA maps, which note which areas might be vulnerable to flooding, NOAA maps and databases allow users to view projected tidal reaches for different levels of SLR.[260] FEMA maps also do not take erosion into account, and erosion is a problem along the Charleston coast. Though the FEMA maps were considered too outdated for use in Charleston's SLR plan, they are still used to determine NFIP coverage in the area. In 2012, Charleston County had 57,794 NFIP policies in place.[261]

Developers of Charleston's SLRA plan chose to use NOAA data because they believed that the NOAA would update its SLR scenarios whenever the available data changed. Williams says that Charleston planners are committed to changing SLR estimates as NOAA releases new data.[262] Charleston's existing SLRA plan cites 2.5 feet of SLR as the suggested consideration for substantial building projects.[263] This number is only intended as a starting point, however. Williams says, "We know it's going to get worse than this."[264]

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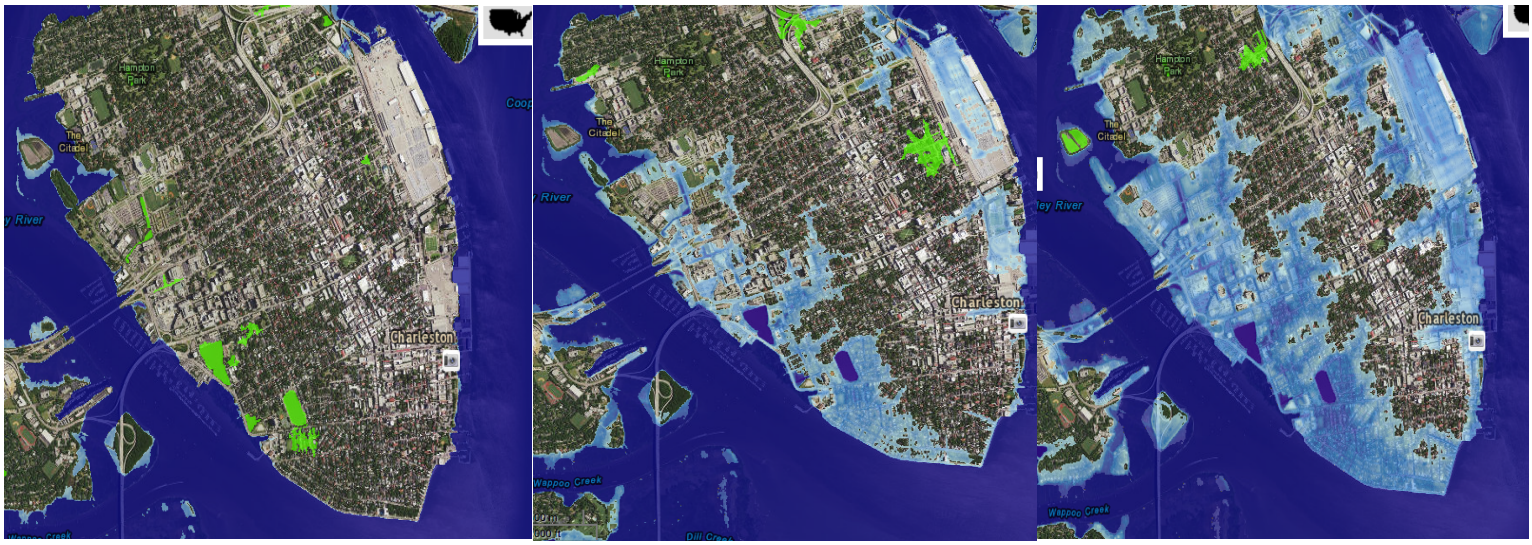
[258]Interview with Carolee Williams, Telephone interview by Emma Eisendrath, January 20, 2017.
[259] GAO, *Status of FEMA's Implementation of the Biggert-Waters Act, as Amended, (*Washington, D.C.: GAO, 2015), accessed January 18, 2017. AND Rachel Cleetus, *Overwhelming Risk.*
[260] "Sea Level Rise and Coastal Flooding Impacts," NOAA, accessed January 22, 2017, https://coast.noaa.gov/slr/.
[261]Wendy Zhao, "Affordability of the National Flood Insurance Program: A Case Study of Charleston County, South Carolina," *Wharton Research Scholars*, published May 7, 2014, accessed January 22, 2017, University of Pennsylvania Scholarly Commons.
[262] Interview with Carolee Williams, Telephone interview by Emma Eisendrath.
[263] City of Charleston, *Sea Level Rise Strategy.*
[264] Interview with Carolee Williams, Telephone interview by Emma Eisendrath.

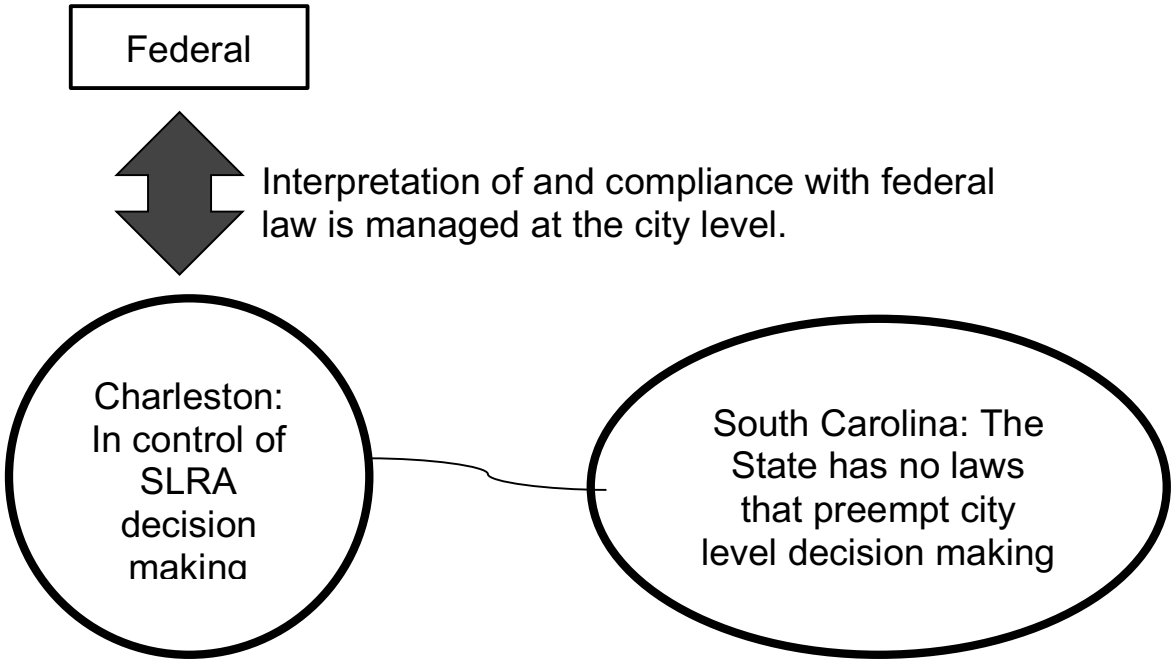
Williams cites one problem with NOAA data: it assumes that topographic data does not change. In fact, Charleston has been actively editing its topography for for the last twenty years to create tunnels to hold flood water. Charleston has several tunnels that are about 100 feet below the ground level.[265] During high tides or heavy rains, flood water is channeled into the tunnels and held there until above-ground pumps activate after the tide has gone back down or the rain has stopped.[266] The first above-ground pump was installed in the mid-1990s and won an architectural award.[267] NOAA data does not take the city's capacity to hold flood water in these underground tunnels into account when analyzing flood risks and flood heights.[268] It remains the best available data set, according to city planners.



NOAA scenario maps of Charleston for 1 ft, 3 ft, and 6 ft[269]

[265] City of Charleston, *Sea Level Rise Strategy.*
[266]Interview with Carolee Williams, Telephone interview by Emma Eisendrath.
[267] Interview with Carolee Williams, Telephone interview by Emma Eisendrath.
[268] Interview with Carolee Williams, Telephone interview by Emma Eisendrath.
[269] "Sea Level Rise and Coastal Flooding Impacts," *NOAA*, digital, accessed January 22, 2017, https://coast.noaa.gov/slr/

4. Categorization



Charleston falls into the category of limited-constraint autonomy. The state of South Carolina has little controlling policy or law related to SLR or SLRA. To combat the significant risk posed by sea level rise in the Charleston area, the city has taken responsibility for SLRA projects and policy making. Charleston's plans rely in part on federal resources, including FEMA and NOAA, and the decision to rely more heavily on NOAA for SLR data was a city-level choice. State law barely mentions FEMA flood maps and includes no requirement that cities adhere to them.

Charleston adheres to federal NFIP and FEMA policy to qualify for NFIP coverage. Without state law requiring NFIP qualification, however, Charleston made this choice independently. Charleston also makes SLRA policy decisions, like the building of drainage systems, without state interference of any kind, positive or negative. This is not because the state

has inefficient SLRA plans or inaccurate SLR data, but because the state law does not preempt any city-level SLRA decision making regarding SLRA.

Charleston's approach to SLRA will likely prove effective in the future. I cannot say whether the physical structures and drainage pumps will serve effectively in flooding events, but Charleston's approach to SLR, which includes consideration of the changing nature of SLR risk, is broad enough to flexibly respond to changing levels of risk. Understanding the changing nature of risk is the key to successful SLRA management. If a city can change its approaches quickly because its management structure is open to accepting changing data, then the city can, hopefully, dive into appropriate structural adaptations quickly enough to prevent disaster.

Charleston successfully fulfills all GCC criteria for effective SLRA management, while none of my other case study cities do. Charleston's comprehensive Strategic Plan covers all six criteria: establishing a baseline SLR to work with, identifying risk, assessing vulnerability, identifying risk areas, planning infrastructure changing, identifying land-use tools, and creating an implementation schedule. None of the other three cities in this paper have written SLRA plans as comprehensive as this one. Charleston's city plan adheres to state law and was developed independently of the state. This demonstrates that cities can engage in SLRA management from a limited-constraint autonomy framework.

	Establish Baseline SLR	**Assess Vulnerability**	**Designate Protected Areas**	**Move public Infrastructure**	**Identify land-use tools**	**Create Implementation Schedule**
Charleston	Yes. The city plan uses a range of 1.5 feet to 2.5	Yes. the Sea Level Rise Strategy Plan assess vulnerability	Yes. The Sea Level Rise Strategy Plan lists protected areas	Yes. Infrastructure has not yet moved, but plans exist to move roads if necessary	Yes. Zoning, building codes, drainage systems	Yes. Specific projects have implementation plans.

CITY GCC COMPLIANCE SUMMARY CHART

	Establish Baseline SLR	**Assess Vulnerability**	**Designate Protected Areas**	**Move public Infrastructure**	**Identify land-use tools**	**Create Implementation Schedule**
Atlantic City	No	No	Yes	No	Yes	Unclear
Hoboken	Yes	Yes	Yes	No	Yes	Yes
NYC	Yes	Yes	Yes	No	Yes	Yes
Charleston	Yes	Yes	Yes	Yes	Yes	Yes

Survey of Other Cities

Rising tides pose a threat to all coastal cities in the United States. This paper looks at four cities in depth: Hoboken, Atlantic City, New York City, and Charleston. To put the analysis of these four cities in a larger context, in this section, I will describe city-state relationships in SLRA in several cities across the country.

Miami Beach, Florida

Florida has a long coastline, reaching 1,350 miles, with over $2.9 trillion of property value in coastal counties.[270] Since the early 1900s, sea levels along the Florida coast has already risen eight inches. According to NOAA data, there may be a four-foot rise by the end of this

[270] Rachel Cleetus, *Overwhelming Risk.*

century, putting the 2.4 million Floridians who live within four feet of the tide line at risk.[271] Miami Beach is one of multiple Florida cities along that coastline with a high population sitting in an area where sea level rise poses a serious risk. In response to rising tides, Miami Beach is raising roads and sidewalks up to two feet along the coastline. The city is also improving its sewers and drainage systems to move floodwater away from homes.[272] The city plans to install half a billion dollar's worth of pumps that shoot water out into Biscayne Bay.

Along with increased sewer and drainage capacity, the city is installing seawalls; they already have three miles worth of 3-foot-tall sea walls, and the city plans to raise them even higher.[273] The city also hopes to regrow its protective mangroves along the coast, which have disappeared over the years for a variety of reasons, including removal to make room for boat shows.[274]

Miami Beach Mayor Philip Levine is committed to building a more resilient city, despite a lack of climate change leadership at the state level.[275] The governor, Rick Scott, does not take a strong stance on climate change; a few years ago, there were rumors that he placed an employee on leave for referencing climate change.[276] There are some statewide climate change and sea level rise related projects, but much of Miami Beach's planning comes directly from the city itself, placing it in the category of limited-constraint autonomy. As the Charleston case study

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[271] Rachel Cleetus, *Overwhelming Risk.*
[272] Francisco Alvarado, "Miami Beach meeting focuses on how to cope with sea level rise," *The Real Deal*, last modified March 18, 2015, accessed March 7, 2017, http://pre-constructionhomes.com/miami-beach-meeting-focuses-on-how-to-cope-with-sea-level-rise/
[273] "Pump It: Inside Miami Beach's $500 Million Plan to Stay Dry," *Fusion*, accessed March 8, 2017. http://interactive.fusion.net/pumpit/
[274] Jenny Staletovich, "Miami cuts Virginia Key mangroves to make way for boat show," *Miami Herald*, last modified June 26, 2015, accessed March 8, 2017. http://www.miamiherald.com/news/local/environment/article25605991.html
[275] Greg Allen, "As Waters Rise, Miami Beach Builds Higher Streets and Political Willpower," *National Public Radio*, May 10, 2016 accessed March 8, 2017, http://www.npr.org/2016/05/10/476071206/as-waters-rise-miami-beach-builds-higher-streets-and-political-willpower
[276]Tristram Korten, "Gov. Rick Scott's ban on climate change term extended to other state agencies," *Miami Herald*, last modified March 11, 2015, accessed March 8, 2017, https://newrepublic.com/article/121341/florida-gov-rick-scotts-ban-climate-change-hasnt-halted-action

demonstrates, limited-constraint autonomy situations can lead to successful SLRA according to GCC criteria.

Kivalina, Alaska

In Kivalina, Alaska, a remote Alaskan town with a population of 400, rising tides are forcing people to relocate.[277] Kivalina is only one quarter of a mile wide at its widest point.[278] Ice formations around the coastline used to protect the land from sea storms and flooding, but because of fluctuations in average temperatures due to climate change patterns, the ice is melting earlier in the year and forming later, leaving the city exposed for much of the year.[279] Alaska participates in NOAA's Sea Grant program, which ties thirty-three state programs together for research, education, and ocean related projects. Alaska Sea Grant defines itself as a "state-federal partnership."[280]

In 1992, the community voted to relocate but received no government aid to facilitate any such movement. They voted to move again in 1998. The town members wanted to move to an area called Igrugaivik, but the Army Corps of Engineers ruled the area unstable. The town voted again, and chose an area called Kiniktuuraq, but the Army Corps again said the site was unstable and subject to erosions.[281] Contrary to the Army Corps' statement, NOAA studies suggested that

[277]Chris Mooney, "The remote Alaskan village that needs to be relocated due to climate change," *The Washington Post*, last modified February 24, 2015, accessed March 06, 2017, https://www.washingtonpost.com/news/energy-environment/wp/2015/02/24/the-remote-alaskan-village-that-needs-to-be-relocated-due-to-climate-change/?utm_term=.a7542613fdef.
[278] Christine Shearer, *Kivalina: a climate change story*, (Chicago, IL: Haymarket Books, 2011).
[279] Christine Shearer, *Kivalina: a climate change story.*

[280] "Alaska Sea Grant Strategic Plan 2018-2021," *Sea Grant Alaska*, last modified February 2017, accessed March 6, 2017, https://seagrant.uaf.edu/research/rfp/2018-2021-strategic-plan.php.
[281] Christine Shearer, *Kivalina: a climate change story.*

Kiniktuuraw was not eroding.[282] In part because of the discrepancies in government agency research and because of the conflicting desires of the city and the response of the federal government, the people of Kivalina have not moved.

The federal government did, however, begin funding adaptation programs. In 2004, FEMA provided funding for sandbags to prevent erosion. In 2005, under the Consolidated Appropriations Act, Congress "allowed the Army Corps of Engineers to carry out storm damage protection projects for Alaska Native villages at full federal expense, waiving the cost sharing requirement."[283] Despite input from town members that a sea wall would be ineffective due to heavy wind, private contractors were hired by the state and the Army Corps of Engineers to build a seawall. Soon after its completion, strong winds blew it apart, as the people of Kivalina had warned.[284]

Kivalina is such a small town that it does not have local authority over its zoning ordinances, building codes, or post-disaster recovery plans. The town does have control over floodplain management, though there is not a designated floodplain manager.[285] Due to the size of the town, all SLRA efforts fall under the category of state mediation. City members have strong views about where to relocate the town or how to properly protect the town, as is evident in the various votes to relocate and the response to the Army Corp's seawall project, but the town does not have the capacity to enact SLRA on its own without state support. As the Atlantic City example demonstrates, state mediation does not lend itself to successful SLRA management under the GCC criteria. Ideally, Kivalina would have the capacity to engage in autonomous decision making, but as the town is so small, SLRA planning requires state involvement.

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[282] Christine Shearer, *Kivalina: a climate change story.*
[283] Christine Shearer, *Kivalina: a climate change story,* 132.
[284] Christine Shearer, *Kivalina: a climate change story.*
[285] "City of Kivalina, Alaska: Local Hazards Mitigation Plan," City of Kivalina, last modified December 14, 2007, accessed March 6, 2017, http://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Arctic-Resources/Community-Adaptation-Plans/Kivalina_AK%20Hazard%20mitigation%20plan.pdf

Norfolk, Virginia

Around Norfolk, Virginia, sea levels are expected to rise between 4.5 and 6.9 feet by 2100.[286] Norfolk is a low-lying area that already experiences tidal flooding at least nine times per year.[287] According to the Union of Concerned Scientists, if sea levels rise to 6.9 feet, tidal flooding could occur around Norfolk up to 280 times a year.[288]

Norfolk is home to the United States' largest naval base, Naval Station Norfolk. The station houses 75 ships and 134 aircraft. It conducts about 275 flights per day.[289] The Naval Station has a population of 6,700.[290] The federal government has a strong interest in protecting the base because. The federal government has paid to raise several of the Naval Station's piers; each raised pier has cost about $60 million each.[291] A $250 million restoration project will begin in the next few years.[292]

Norfolk's "Coastal Resilience Strategy" outlines other available resources, including FEMA, neighboring towns, and residents.[293] The plan does not mention any form of state aid.[294] The city of Norfolk receives some federal aid, but not as much as the federally run naval base does. Most city projects that involve federal aid are organized between the city and federal government, without significant state involvement. Projects developed between the city and federal government include a $18.4 million beach restoration project in partnership with the

[286] Union of Concerned Scientists, *The US Military on the Front Lines of Rising Seas*, last modified July 2016, accessed March 8, 2017, http://www.ucsusa.org/sites/default/files/attach/2016/07/front-lines-of-rising-seas-naval-station-norfolk.pdf
[287] Union of Concerned Scientists, *The US Military on the Front Lines of Rising Seas.*
[288] Union of Concerned Scientists, *The US Military on the Front Lines of Rising Seas.*
[289] "Welcome to the World's Largest Naval Station," *Military.com*, accessed March 8, 2017, http://www.military.com/base-guide/naval-station-norfolk
[290] Union of Concerned Scientists, *The US Military on the Front Lines of Rising Seas.*
[291] Union of Concerned Scientists, *The US Military on the Front Lines of Rising Seas.*
[292] Union of Concerned Scientists, *The US Military on the Front Lines of Rising Seas.*
[293] City of Norfolk, *Coastal Resilience Strategy*, accessed March 8, 2017, http://www.norfolk.gov/DocumentCenter/View/16292
[294] City of Norfolk, *Coastal Resilience Strategy.*

Army Corps of Engineers.[295] The city runs its own flooding studies, which have led to a city-wide rule that buildings must be raised at least three feet above predicted flood heights.[296] Like Miami Beach and Charleston, Norfolk provides an example of limited-constraint autonomy, where the city does much of its own planning and interacting with federal resources without state mediation. Limited-constraint autonomy situations are most effective for successful SLRA management under the GCC criteria.

Seattle, Washington

According to Climate Central, sea level rise will cause major flooding in Washington state within the next two decades, with much of that flooding concentrated in the Puget Sound area.[297] Sea level rise in this area of the United States is projected to be slightly lower than in other coastal areas because tectonic plate movement along the coast is pushing land upwards between 1.5 and 3 millimeters a year.[298] This rise is not consistent across the West Coast. South of Cape Mendocino, California, the West Coast is sinking between .6 and 3.7 millimeters a year.[299] Even within Washington, the rise is inconsistent. Close to Puget Sound, the land is sinking, in an effect that NOAA describes as "like pushing one coin under another; as one edge of the second coin tilts up, the other tilts down."[300] Since the land rise is minimal and

[295] City of Norfolk, *Coastal Resilience Strategy.*
[296] City of Norfolk, *Coastal Resilience Strategy.*
[297] Climate Central, *Puget Sound Epicenter of Sea Level Rise Exposure in Washington State, published* June 2011, accessed March 9, 2017. http://www.climatecentral.org/pdfs/SLR-WA-PressRelease.pdf
[298]Eric Scigliano, "The land also rises (and falls)," last modified December 22, 2014, accessed March 9, 2017. http://seagrant.noaa.gov/News/FeatureStories/TabId/268/artmid/715/articleid/461/The-land-also-rises-and-falls.aspx
[299] Eric Scigliano, "The land also rises (and falls)."
[300]Eric Scigliano, "The land also rises (and falls)."

inconsistent across the coastline, the net difference between projected land rise and projected sea level rise amounts to a four-millimeter sea level rise per year.[301]

Washington state, under the Sea Grant program and the Department of Ecology of the State of Washington, has created the Washington Coastal Hazards Resilience Network (WCHRN). The WCHRN is a statewide group of hazard and climate change experts from a variety of organizations, levels of government, nonprofit organizations, and academic institutions.[302] The group provides recommendations to state and local governments on SLRA. Washington state law grants individual counties permission to enact SLRA projects of their own, separate from any statewide projects. Under Title 86 of the Revised Code of Washington,

> "Any county, for the control of waters subject to flood conditions from streams, tidal or other bodies of water affecting such county, may inside or outside the boundaries of such county, construct, operate and maintain dams and impounding basins and dikes, levees, revetments, bulkheads, rip-rap or other protection; may remove bars, logs, snags and debris from and clear, deepen, widen, straighten, change, relocate or otherwise improve and maintain stream channels, main or overflow….and may construct, operate and maintain any and all other works, structures and improvements necessary for such control…."[303]

With this law in place, all cities in Washington can engage in SLRA in the category of limited-constraint autonomy.

Seattle does have its own broad climate change adaptation plan, but the actual planning document only includes vague plans to address SLR. Though the planning document lacks specific actions towards SLRA, it does include significant amounts of information on SLR risks in the area.[304] Using NOAA data and a risk map from Seattle Public Utilities, the document includes projections of a 9-inch base sea level rise by the 2030s and a 19-inch rise by the 2050s. This rise could lead to a 57-inch-high tide during a storm surge in the 2050s.

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[301] Eric Scigliano, "The land also rises (and falls)."
[302] "About," *Washington Coastal Hazards Resilience Network*, accessed March 9, 2017. http://www.wacoastalnetwork.com/
[303] WASH. REV. CODE § 86.12.20 (1970).
[304] Seattle Office of Sustainability and Environment, *Preparing for Climate Impacts*, published August 2016, accessed March 9, 2017, http://www.seattle.gov/environment/climate-change/planning-for-climate-impacts

Though Seattle has yet to enact significant SLRA, under Washington State law, it has the authority to function under limited-constraint autonomy or with aid from the state, leading to a cooperative governance approach. At present, it is unclear which approach the city and state will take. I cannot categorize a city that has yet to engage in substantive SLRA, so I cannot predict whether Seattle might successfully fulfill the GCC criteria.

Summary of Other Cities

These brief studies provide a greater context to understand the in-depth studies by showing governance trends in other at-risk cities. Of these four cities, two approach SLRA from a limited-constraint autonomy approach. This might suggest that limited-constraint autonomy is both the most effective and the most common governance model for SLRA, but further research is necessary to claim a clear trend. These short studies do confirm, however, that both limited-constraint autonomy and cooperative governance occur where cities and states agree about the importance of climate change adaptation. State mediated SLRA occurs where cities are incapable of enacting adaptive projects on their own; Kivalina is too small to engage in SLRA and Atlantic City is too financially unstable. Seattle poses a different scenario than any of the other cases because the city has yet to enact substantial adaptive plans.

Miami Beach	**Kivalina**	**Norfolk**	**Seattle**
Limited-constraint autonomy	State mediated	Limited-constraint autonomy	Unclear levels of autonomy

Conclusion

This paper evaluated the efficacy of levels of city autonomy in SLRA preparedness. To do that, I developed a framework to describe levels of autonomy in city decision making about SLRA and developed four case studies where this framework could be applied. I then used those cases to answer my main question: which of the governing structures listed in my theory framework is most effective for fulfilling the Georgetown Climate Center criteria for successful SLRA preparation?

Only the limited-constraint autonomy example in Charleston fulfilled all six of the Georgetown Climate Center's criteria for successful SLRA management. Examples of cooperative governance in New York City and of conflicted autonomy in Hoboken were each somewhat successful. The state-mediated approach of Atlantic City fulfilled only two of the criteria, proving that city-level management is more effective than state directed efforts for SLRA.

I cannot evaluate the effectiveness of actual barrier mechanisms, drainage systems, and zoning laws for SLRA management as these mechanisms will not be put to the test until sea levels rise further. I can, however, predict which cities have most successfully prepared for SLRA based on their ability to fulfill the GCC criteria. Charleston hits each of the GCC criteria, proving that cities have the capacity to prepare for SLR in a limited-constraint autonomy scenario. A limited-constraint autonomy approach is effective because it allows the city flexibility to engage in targeted research and planning. Atlantic City is the least successful in planning for SLR because of its state mediated approach to SLRA. Cities can more flexibly prepare for SLR when they are not bound to state-level plans that ignore the reality of climate change.

I expect that of the four cities, Charleston's plans will prove the most effective in the long term for the additional reason that city leaders spent less time on intergovernmental lobbying and more time thinking about how to respond to rising sea levels. Under a limited-constraint autonomy approach, city planners can make policy changes without state involvement. Gaining the required political consensus at the state and the federal levels is more difficult. Consequently, it is reasonable to expect policy formulation at higher levels of government to be slower and less focused. City residents share experiences and interests, which often makes it easier to gain consensus and a sense of urgency about policy matters. Cities like Charleston, surrounded by water and forts, where defense against threats from the sea is a long-established habit, are better positioned than states to lead in SLRA preparation. In states where governing officials are ignorant of the science, this autonomy allows city planners to make decisions about SLRA without having to convince a larger governing body of the dangers of climate change. South Carolina is such a state, yet city planners, including Carolee Williams, have made forward looking policy decisions that emphasize the importance of climate adaptation. Forward looking cities, like Charleston, must continue take concrete action with or without state involvement on SLRA.

In the climate change section of this paper I showed that data about SLR is continuously changing; the ice-melt cycle feeds itself, causing water heights to rise faster over time. Consequently, a city's approach to data and to changes in data will be a factor in its ability to prepare. Cities can work directly with federal resources, like NOAA and FEMA, but must also have their own research and planning bodies, such as the NPCC and the Charleston Planning Department, to make up for policy gaps at the federal and state levels. Limited-constraint autonomy allows Charleston to effectively work with the federal government to use NOAA and

FEMA data, in addition to city and state-collected data, to develop SLRA policies based on the amalgamation of multiple reliable data sources. Similarly, the ability of New York State and New York City to come together and share resources through the New York State Emergency Research and Development Authority and through the New York Panel on Climate Change ensures that data is frequently updated and cross checked, making it more reliable than if either the city or state were the sole generator of SLR data.

One interesting outcome of the work presented here is a sense that, from a pragmatic perspective, the effort to combat general climate change itself may not be the best tactic for those who care most about sea level rise. The climate is changing, yet at the highest level of government, policy makers, are ambivalent about their approach to the overarching problem. There is little reason to believe that climate change deniers in the federal government will switch sides, but my research shows that SLRA preparedness is still possible in individual cities when higher levels of government disagree about climate change in general. If cities take control of SLRA planning in instances where the state is ill prepared, significant progress towards adaptation is possible despite limited work towards mitigating climate change at the federal level.

Before the 2016 election, 131 members of the US House and thirty-eight members of the U.S. Senate were self-defined climate change deniers.[305] After the election, the total number jumped to 182 climate deniers in both the House and Senate.[306] Already, President Trump, his administration, and the Republican majority in both the Senate and House are trying to dismantle any Obama era progress, including stipulations of the Paris Agreement. The latest proposed federal budget makes significant cuts to the EPA and NOAA. The ability of cities to engage in

[305] Fisher Stevens, *Before the Flood*, Film, directed Fisher Stevens (2016); National Geographic Channel.) Web.
[306] "182: Total Number of Climate Deniers in Congress," *EcoWatch*, last modified March 14, 2016, accessed April 4, 2017. http://www.ecowatch.com/182-total-number-of-climate-deniers-in-congress-1882189472.html

effective SLRA management under multiple governing patterns is at least some good news in the face of federal retreat from climate change adaptation and mitigation.

This paper looks at as many cities as was possible for me at this time. I selected four primary cities to study, each of which already has engaged in SLRA. A future research project should include analysis of coastal cities that are not currently engaging in SLRA, like Seattle, to determine further factors that prevent SLRA preparation. I expect, however, that the pattern of limited-constraint autonomy as the most effective structure for hitting GCC criteria would remain the same.

The findings in this paper allow for an optimistic look at the future of SLRA. If cities take control of SLRA, or work with states in instances where the state takes a proactive approach to SLRA, cities can fulfill most, if not all, of the GCC criteria for preparedness. FEMA needs to update its mapping systems to include analysis of future risk, but until it does, cities must continue to use multiple data sources, like NOAA and state or city-sponsored research programs. With the collection of adequate data that assesses both current and future risk, city-focused adaptation efforts can prove effective in a rapidly changing climate.

Glossary

- **ACV:** Actual Cash Value
- **Coastline-** The boundary between the coast and the shore[307]
- **CRS:** Community Rating System, incentive program for communities to go beyond the basic NFIP requirements to earn lower insurance premiums
- **DEC:** NY Department of Environmental Conservation
- **DHEC- CD:** South Carolina Department of Health and Environmental Control - Coastal Division
- **EPA:** Environmental Protection Agency
- **FEMA:** Federal Emergency Management Agency
- **Floodwall**- Permanent structure typically made of reinforced concrete or stone[308]
- **GHG:** Greenhouse Gas
- **GIS:** Geographic Information Systems
- **HHW-** (Higher High Water) The highest of two tidal peaks during a day[309]
- **HUD:** US Department of Housing and Urban Development
- **Levee**- Flood barrier made of compacted soil[310]
- **MHHW-** (Mean Higher High Water) The average of higher high water levels over a set period[311]
- **NDRC:** National Disaster Resilience Competition

[307] "Coast and Shore," Science Clarified, accessed January 23, 201, http://www.scienceclarified.com/landforms/Basins-to-Dunes/Coast-and-Shore.html
[308] FEMA, *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures,* published 2013, accessed January 23, 2017, https://www.fema.gov/media-library/assets/documents/3001
[309] "Glossary of Coastal Terminology," *Southwest Washington Coastal Erosion Study.*
[310] FEMA, *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures.*
[311] "Glossary of Coastal Terminology," *Southwest Washington Coastal Erosion Study*, accessed January 23, 2017, http://www.ecy.wa.gov/programs/sea/swces/products/glossary.htm

- **NFIP**: National Flood Insurance Program
- **NJCAA:** New Jersey Climate Adaptation Alliance
- **NJDEP:** New Jersey Department of Environmental Protection
- **NOAA:** National Oceanic and Atmospheric Association
- **NPCC:** New York Panel on Climate Change
- **NYSERDA:** New York State Emergency Research and Development Authority
- **SCEMD:** South Carolina Emergency Management Division
- **SFHA:** Special Flood Hazard Area
- **Shoreline-** The changing boundary between the water and the land[312]
- **SLR:** Sea Level Rise
- **SLRA:** Sea Level Rise Adaptation
- **SLRTF:** New York State Sea Level Rise Task Force
- **Wet Floodproofing-** using water resistant materials to create a pathway for floodwater to enter a building with minimal damage[313]
- **100- year flood**- A term used to describe a flood that appears roughly every 100 years. In a 100-year floodplain, this flood has a 1% chance of occurring on any given year.[314]
- **500- year flood**- A flood that occurs roughly once every five hundred years. This flood has a .20% chance of occurring on a given year.[315]

[312] "Coast and Shore," Science Clarified.
[313] "Wet Floodproofing," *FEMA*.
[314] "The 100 Year-Flood," USGS, last modified December 9, 2016, accessed January 23, 2017, https://water.usgs.gov/edu/100yearflood-basic.html
[315] "The 100 Year-Flood," USGS.

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44 U.S. CRF ch. 1 § 60.3 (a) (4) (1976).

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I affirm that I have adhered to the Honor Code in this assignment. –Emma Eisendrath